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Agricultural research will lead the march toward America's farm production goals

OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO, U. S. A.

MEET YOUR AUTHORS!


Morison

F. L. Morison presents significant facts on Ohio's farm labor supply—a big question mark that must be erased before Ohio farms meet 1943 production goals.

No strangers to Bimonthly readers are D. C. Kennard and V. D. Chamberlin, developers of new equipment for growing chickens "close to the grass roots" and satisfactory, economical rations and methods of feeding that will help poultrymen boost wartime production.


Kennard


Chamberlin

For those thinking in terms of apples from their own orchards, C. W. Ellenwood has practical suggestions for starting a new orchard or rejuvenating an old one.


Ellenwood

To cut down the losses greenhouse growers take when tomato fruits turn out small or of poor quality or fail to develop at all because of faulty pollination, Freeman S. Howlett offers results of his work with growth-promoting chemicals on tomato flowers.


Howlett

Storing Ohio's valuable corn crop is a problem yet unsolved, as the 14 to 45 per cent of the harvested crop that becomes a total loss each year grimly reveals. But G. R. Shier, R. C. Miller, and W. A. Junnila in this issue present promise of a solution.


Shier


Miller

A veteran member of the Ohio Agricultural Experiment Station's Dairy Department, A. E. Perkins has led the way to solving many a silage problem.


Perkins

Familiar throughout Ohio to growers who have had plant disease problems is J. D. Wilson of the Station's Botany and Plant Pathology Department.


Wilson

For many years, J. I. Falconer's figures on Ohio farm products prices, wages, and real estate, as well as prices paid by farmers for the things they must buy, have interested Bimonthly readers.


Falconer

IN THIS ISSUE

THE OHIO FARM LABOR SITUATION

F. L. MORISON

A study of the Ohio farm labor situation was made during the months of October and November, 1942.[1] Part of this work was the study of 477 farms located in 16 typical communities in widely separated sections of the State.

This study revealed that there was approximately 8 per cent less manpower on these farms in 1942 than there had been in 1941. This reduction, amounting to an average of 1.8 months of man labor per farm for the year, does not take into account the longer days and the harder physical work which the operator and the members of his family put in during the past year. A large part of the reduction in manpower on Ohio farms was due to decreases in the numbers of regular hired men and male members of the operator's household between the ages of 18 and 45. These reductions were only partially offset by more work on the part of farm women, farm children of school age, and older men in the family, such as the operator's father.

In 1942, about one-half of the total labor on Ohio farms was performed by the operator, one-fourth by family labor, and one-fourth by hired labor, including both seasonal and regular help. Seasonal hired help was employed by nearly twice the number of farmers who kept a regular hired man on a monthly basis, although the latter kind of hired labor was more important in the aggregate.

An enumeration was made of all regular farm workers, including the operator, members of his family who were available for any farm work, and regular hired men. This enumeration showed that 6 per cent of the farms had more workers in October 1942 than a year ago; 70 per cent had the same number; and 24 per cent had fewer workers. On the entire 477 farms, there was a net loss of 99 workers, or about 1 less worker for every 5 farms. Most critical losses were the 23 per cent decline since October 1941 in the number of male family workers (other than the operator) between the ages of 18 and 45 and the 36 per cent decrease in the number of regular hired men.

The farm labor force is thus reduced not only in numbers, but also in experience. In October 1941, these 477 farms had a total of 214 regular hired men. During the 12-month period ending October 1942, 138 of these hired men left the farm, and only 60 new regular hired men were recruited. Of the latter number, only 38 had come from other farms. Nine had been working at industrial or other jobs, and 13 had been on WPA in 1941 or unemployed because they were ill or too old to work in industry. Only about half the farmers' sons who went to the armed services or to industry have been replaced. These replacements have often been by farm children not old enough to work in 1941. A number of farm women also helped with the milking or with field work for the first time in several years.

About seven farm workers went into the armed forces during the year for each six who left for industrial employment. To be sure, industry began to draw workers away from

[1]Mimeograph Bulletin No. 157, Department of Rural Economics and Rural Sociology, The Ohio State University, Columbus, Ohio. December 1942.

the farm long before the enactment of the Selective Service Act. There was some migration of industrial workers back to the farm, however, and in the past year, it would appear that the net loss of farm workers to industry has not been as large as the number who left the farm to enter the armed services.

In October 1942, about 19 per cent of the farms had workers to whom induction into the armed services appeared imminent. These farms were about one-third larger than the average of the entire group of farms studied, both in crop acreage and in livestock numbers. Agricultural production of 1943 will depend in no small part on the action which local draft boards take in cases comparable to these. Recent changes in selective service regulations should be of help in preventing further depletion of the manpower on farms, but the movement to industry will continue unless means are taken to control it.

It was also apparent from the study that many small farms, generally lacking in capital and farm equipment, still have a surplus of farm labor. How to utilize more fully the labor resources of such farms is one of the problems to be solved before farmers attain their 1943 production goals.

WARTIME RANGE EQUIPMENT

D. C. KENNARD AND V. D. CHAMBERLIN

The wartime scarcity and high cost of certain vitamin products required for the indoor feeding of chicks, growing pullets, and 3- to 5-pound chickens for meat purposes in 1943 will necessitate more than ever the growth of chickens on green range, where only a simple, inexpensive ration composed mainly of whole grain supplemented with the less expensive vegetable proteins and simple, inexpensive minerals is needed.

Going back to the "grass roots" for raising chickens in 1943 and for the duration will find many poultry raisers short on range equipment. Moreover, wire and sheet metal, which have been used so freely, may be unavailable. Poultrymen will be called upon to exercise their ingenuity to make equipment from material generally available on the farm. To aid poultrymen in this task, the Ohio Agricultural Experiment Station at Wooster has designed a range shelter and labor-saving feeding and watering equipment which require the use of no metal except nails. Being made of wood, this equipment can be built of material readily available on most farms.

RANGE SHELTER

Dimensions of the shelter can be varied to suit the needs and desires of individual poultry raisers. The shelter designed by the Ohio Station, shown in figure 1, is 5 by 8 feet to accommodate 75 to 100 pullets. Height of the front is 4, of the rear, 2 feet.

Fig. 1.—Wartime range shelter with feed sled at rear

The skids are 2 by 8 inches and 8 feet long with two 2 by 4-inch crossties (flatwise) spaced about 30 inches apart for floor supports. The slatted floor consists of 1 by 1-inch strips lengthwise spaced 1½ inches apart. The front corner supports are made of a 1 by 6-inch board facing the front and boxed to a 1 by 4-inch board facing the ends. The 1 by 6-inch front facing boards extend 4 inches below the 2 by 4-inch floor joist onto the side of the front skid to tie the roof framing, floor framing, and front skid securely together and to give rigidity to the front skid. The boxing for rear corners consists of 1 by 6-inch pieces nailed (boxed) to the first rear siding board on each end. The rear wall is entirely enclosed with 1 by 8- to 12-inch boards. These boards extend 4 inches below the floor joist onto the outside of the rear skid to tie the floor and roof framing securely together and give rigidity to the rear skid. The front and ends are enclosed with plaster lath spaced 1½ inches apart. The frame for the 2 by 4-foot door consists of 2 by 4-inch pieces flatwise faced with 1 by 6-inch boards which extend 4 inches

below the floor joist on the outside of the skid to tie the center of the roof and the floor frame and front skid securely together and afford additional rigidity to the front skid. The 2 by 4-foot door is framed with 1 by 3-inch pieces and enclosed with plaster lath spaced 1½ inches apart. The roof is made of native oak boards 1 by 8 to 12 inches wide, and the cracks between boards are covered with plaster lath. (Other strips of wood could be used.) A 2 by 4-inch piece edgewise through the center from end to end supports the center of the roof.

The slatted floor is self-cleaning and, what is more, obviates the need for roosts. Wood slatted floors have long been popular with English poultrymen even when wire was readily available. The slatted floor in the Station's range shelter is completely self-cleaning and is preferable to wire floors in some ways, especially for the comfort of the birds.

The range shelter described has been so satisfactory that poultrymen need have no concern over the necessity of making and using this type of range shelter, built without the use of wire or sheet metal from materials generally available on the farm.

LABOR-SAVING EQUIPMENT

A major task in caring for chickens on range is to provide water and feed.

WATERING EQUIPMENT

The equipment shown in figure 2 will serve for one or two colony houses, and a 50-gallon barrel of water will generally last a week or more. When more water is needed, the sled and barrel can be drawn by a horse to the source of water supply and returned with the barrel full. The only metal in this outfit is the barrel hoops and the nails; even the faucet, a vinegar spigot, is made of wood.

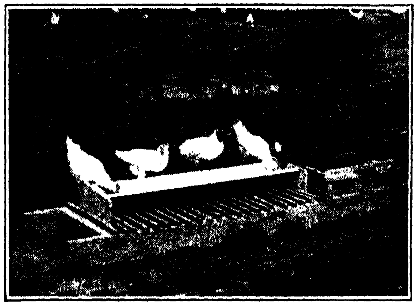

Fig. 2.—A labor-saving watering outfit for chickens on range

The sled, which consists of two 2 by 6-inch pieces of white oak 8 feet long, is 30 inches wide outside to outside. The water barrel sits on a 2 by 2½-foot frame made of two by sixes. The 2 by 6-inch cross supports for the barrel are mortised into sled runners 1 inch. The 2 by 6-inch sides of the barrel frame support extend 1 inch below the top on the inside of the runners, where they are spiked to the runners. The top of the frame support for the barrel is boxed in with two 1 by 10-inch boards spaced about 4 inches apart as shown in figure 2. A 1 by 2-inch cleat is nailed flatwise on each of the four sides of the barrel frame support to hold the barrel in place. The barrel frame support provides the desired elevation of the barrel so that the spigot can be put close to the bottom of the barrel to make practically all the water available to flow into the trough. The slatted floor under the trough consists of 1 by 1-inch pieces spaced 1½ inches apart.

It will be observed in figure 2 that the sled runners are made rigid by the barrel frame support and by the 2 by 4-inch cross supports mortised into runners, one in the center and the other at the end of the sled.

FEED SUPPLY EQUIPMENT

A sled and two barrels, one for whole grain and one for mash, constitute the range feed supply equipment. The feed sled is the same as the one for water equipment except that there is a 2 by 4-inch cross support instead of the barrel frame support like the one in the center and at the trough end of the water sled. The feed barrels are supported by 1 by 10-inch boards placed crosswise of the sled and spaced 2 inches apart. The feed barrels are held in place by 1 by 2-inch strips nailed flatwise to the sides and ends of the sled.

As the construction of the range shelter and feeding and watering equipment is comparatively simple, it is believed that poultrymen who study figures 1 and 2 and follow the detailed descriptions will have no difficulty in constructing this equipment. Poultrymen who want further instructions can secure them by writing to the Ohio Agricultural Experiment Station, Wooster, Ohio.

RATIONS FOR GROWTH OF CHICKENS

D. C. KENNARD AND V. D. CHAMBERLIN

Primary objects in raising chickens are to produce pullets for egg production and chickens for meat. Owing to increased demands for meat production of all kinds to satisfy wartime requirements, poultry raisers are being urged to grow more chickens, especially 3-pound broilers, to supplement the Nation's meat supply. Considering the abundance of feed supplies (except certain animal protein and special vitamin products) and that 12 to 15 pounds of feed costing 30 to 40 cents will produce a 3- to 3.5-pound liveweight chicken for meat purposes, it is obvious that chickens offer untold possibilities for supplemental meat production during wartime. Since chickens weighing 3 to 4 pounds can be produced and marketed within 3 to 4 months after the chicks are taken from the incubator, the growth of chickens is the most important and dependable means by which a quick replenishment of meat supplies can be made during wartime.

As feed constitutes the largest item of expense[1] in the growth of chickens, the ration and method of feeding and their bearing upon the rate of growth and economy of meat production become most important considerations in broiler production.

The availability and price of certain feed products entering into the ration often make changes and the substitution of certain ingredients advisable. These changes involve such questions as: Can whole wheat be substituted for whole corn? Will ground wheat serve to replace bran and middlings? Can oats be omitted from the ration? Can a satisfactory ration be made without the use of milk? An experiment with the growth of chickens was recently completed by the Ohio Agricultural Experiment Station at Wooster to secure firsthand information on these questions.

PLAN OF EXPERIMENT

The experiment was conducted with a mixture of Leghorn pullets, Rhode Island Red pullets, and Rhode Island Red cockerels confined indoors. It was recognized that it was a poor management practice to brood and grow the different kinds of birds together, but this condition did provide a direct comparison of the growth and behavior of the different kinds of birds when running together, which is of interest in itself.

All groups received the same 18 per cent protein, all-mash chick starter during the first 7 weeks. During the fifth and sixth weeks, whole corn and oats were scattered over the top of the mash in the morning in about the amount that would be consumed during the day, to allow the chicks 2 weeks to become accustomed to the whole grain before the beginning of the experiment, in which all groups were given the free choice of whole grain and mash.

THE RATIONS

Percentages of ingredients, prices, and cost per 100 pounds of mash are given in table 1. Feed prices were those considered average in the vicinity of Wooster during 1942; no attempt is made to state current

[1]54.3 per cent of total cost as reported in Purdue University Bulletin 441. 1939.

price quotations. Groups 1, 2, and 5 received whole oats—mash mixtures in which 20 per cent whole oats was mixed with the mash ingredients.

TABLE 1.—Ingredients of feed mixtures and prices

Ingredients	Price per hundred-weight	Group numbers and feed mixtures* 1	2	3	4	5
Whole grain:						
Corn	$1.80	F. C.‡	....	F. C.‡	F. C.‡	F. C.‡
Wheat	1.50	....	F. C.‡	F. C.‡	....	....
Oats	1.90	20§	20§	....	....	20§
Mash:						
Corn, coarsely ground	1.90	22	22	37	30	18
Wheat, coarsely ground	1.60	....	....	30	30	30
Wheat middlings	2.10	20	20	....	....	....
Wheat bran	2.00	10	10	....	10	....
Meat scraps, 50 per cent protein	3.85	5	5	8	7	6
Dried whey	8.00	5	5	5	....	5
Soybean oil meal	2.30	10	10	12	10	12
Alfalfa leaf meal (dehydrated)	2.90	5	5	5	10	6
Salt	1.00	1	1	1	1	1
Oyster shells, chick-size	.75	2	2	2	2	2
Granite grit, chick-size	.75	2	2	2	2	2
Vitamin A and D feeding oil (400 AOAC units D per gram)	50.00	.2	.2	.2	.2	.2
Percentage protein† of mash or whole oats—mash mixture	....	17.4	17.4	16.9	17.5	16.8
Cost of mash or whole oats—mash mixture per 100 pounds	....	$2.53	$2.53	$2.45	$2.18	$2.42

*Percentage ingredients not including grit and feeding oil.
†Calculated.
‡Free choice.
§Whole oats—mash mixture.

DISCUSSION OF RESULTS

The number of birds in each group and feed consumption are given in table 2. The results of groups 1, 2, 3, and 4 are averages of duplicate groups; those of group 5, of a single group.

TABLE 2.—Feed consumption of Leghorn pullets and Rhode Island Red pullets and cockerels

June 10 to August 12, 1942—9 weeks

Group and ration number	Number and kind of birds: Leghorn pullets	Rhode Island Red pullets	Rhode Island Red cockerels	Total	Percentage intake of—: Whole corn	Whole wheat	Whole oats	Total whole grain	Mash	Pounds of total feed per bird
1	88	57	40	185	30.5	None	13.9	44.4	55.6	9.88
2	97	60	42	199	None	35.2	13.0	48.2	51.8	9.32
3	93	80	55	228	14.9	23.5	None	38.4	61.6	8.87
4	99	89	45	233	26.4	None	None	26.4	73.6	8.53
5	41	19	13	73	25.1	None	15.1	40.2	59.8	9.51

The popular contention that chickens will eat too much whole wheat if given all they will eat by the free-choice method was not borne out by groups 2 and 3. The whole wheat consumption of group 1 exceeded the whole corn intake of group 2 only 5 per cent. From the whole grain consumption of groups 1, 2, 3, and 5, it would seem that there should be no fear of giving growing chickens confined indoors all the whole wheat they will eat, and certainly chickens on a green range can be given all the whole wheat they will eat, even to the exclusion of whole corn or oats, when wheat costs less.

The low intake of whole corn by group 4 was probably due to the large proportion of coarsely ground corn and wheat in the mash. The total pounds of feed requirement per bird for group 4, which received no dried whey, was less than that of any of the other groups.

How the birds actually balanced their rations, as indicated by the percentage intake of feed ingredients, and the cost per 100 pounds of total feed consumed during the 9-week experiment are recorded in table 3. It will be seen at a glance that by the free choice of whole grain and mash, all groups precisely balanced their rations so that the variation of total protein intake of all groups was less than 1 per cent. In fact, each of the rations, as actually formulated by the five different groups of birds, could be made a good, well-balanced, complete all-in-one feed mixture for growth of pullets or broilers indoors by simply coarsely grinding the corn and wheat and mixing them with the mash to make a single feed mixture.

TABLE 3.—Average percentage intake of feed ingredients of total feed
June 10 to August 12, 1942—9 weeks

Ingredients	Group numbers and percentage ingredients of rations*				
	1	2	3	4	5
Whole grain:					
Corn	30.5	....	14.9	26.4	25.2
Wheat	....	35.2	23.5	....	....
Oats	13.9	13.0	....	....	15.0
Mash:					
Corn, coarsely ground	15.3	14.3	22.8	22.0	13.5
Wheat, coarsely ground	....	....	18.5	22.0	22.4
Wheat middlings	13.9	13.0	....	....	....
Wheat bran	6.9	6.5	....	7.4	....
Meat scraps, 50 per cent protein	3.5	3.2	4.9	5.2	4.5
Dried whey	3.5	3.2	3.1	....	3.7
Soybean oil meal, 41 per cent protein	6.9	6.5	7.4	7.4	9.0
Alfalfa leaf meal (dehydrated)	3.5	3.2	3.1	7.4	4.5
Salt	.7	.6	.6	.7	.7
Oyster shells, chick-size	1.4	1.3	1.2	1.5	1.5
Granite grit, chick-size	1.4	1.3	1.2	1.5	1.5
Vitamin A and D feeding oil (400 AOAC units D per gram)	.14	.13	.12	.15	.15
Percentage protein†	14.8	15.5	14.9	14.6	15.3
Percentage whole grain	44.4	48.2	38.4	26.4	40.2
Percentage mash	55.6	51.8	61.6	73.6	59.8
Cost per 100 pounds of total feed consumed	2.31	2.17	2.13	2.07	2.26

*Excluding grit and feeding oil.
†Calculated.

The whole oats were fed as a whole oats—mash mixture; that is, the whole oats and mash were mixed and fed as one feed mixture. This is a highly satisfactory procedure both for growing chickens and for layers. Feeding the whole oats—mash mixture avoids the waste of oats so often experienced when whole oats, especially lightweight oats, are fed separately. Moreover, chickens prefer whole oats to ground oats in the mash, and use of the whole oats—mash mixture eliminates the need and expense of grinding oats.

In the several years of experience with the whole oats—mash method of feeding by this Station, it has been found that 20 per cent whole oats, mixed with 80 per cent of the mash, makes a desirable combination for a whole oats—mash mixture for feeding growing chickens or layers.

Although the cost of the mash without dried whey, received by group 4 (table 1), was 24 to 35 cents less than that of the other groups (table 1), this difference was materially reduced to 10 to 24 cents on the basis of total feed intake (table 3) because of the greater proportion of mash consumed by group 4. Nevertheless, group 4 took third place in the cost of feed per pound of gain, as shown in table 4, which gives the growth, feed requirements, and costs.

TABLE 4.—Growth, feed requirements, and costs

June 10 to August 12, 1942—9 weeks

Group and ration numbers	Weight per bird, pounds					Pounds of feed per pound of gain†	Cost of feed per pound of gain,† cents
	Leghorn pullets		Rhode Island Red pullets		Rhode Island Red cockerels, final		
	Initial	Final	Initial*	Final			
1	0.80	2.27	0.84	3.07	3.30	4.75	10.97
2	.78	2.22	.82	2.65	3.47	4.67	10.13
3	.85	2.13	.92	2.85	3.39	4.55	9.68
4	.89	2.08	.90	2.61	3.32	4.80	9.94
5	.80	2.31	.82	2.88	3.98	4.23	9.56

*Average initial weight of Rhode Island Red pullets and cockerels.
†Average of Leghorn pullets, Rhode Island Red pullets, and Rhode Island Red cockerels from 8 to 16 weeks.

Undoubtedly, the mixture of Leghorn pullets, Rhode Island Red pullets, and Rhode Island Red cockerels adversely affected the rate of growth of all. The pounds of feed and cost per pound of gain are the averages for the three kinds of birds and are, therefore, not to be considered representative of any one kind. It is interesting to note that group 5, which received coarsely ground wheat instead of bran and middlings, yielded the highest rate of growth of Leghorn pullets and Rhode Island Red cockerels. As this was a single group, however, and not duplicated as were the other four groups, the results can hardly be considered significant, owing to the smaller number of birds involved. Nevertheless, where it is desirable for the poultry raiser to use coarsely ground wheat instead of bran and middlings, ration No. 5 is deserving of favorable consideration for growing chickens after the first 7-week starting period.

In the study of tables 1, 2, 3, and 4, group 1 can be considered as having received a well-recognized mash control (similar to the "Ohio 1942 18" per cent protein chick starter, with the exception that whole oats were mixed with the mash). It will be observed in table 4 that although this ration yielded good results, it ranked fourth in the pounds of feed required per pound of gain and highest in cost of feed per pound of gain.

Group 2 received the same whole oats—mash mixture, but with the free choice of whole wheat instead of whole corn. These birds did not eat too much wheat, and the free choice of whole wheat proved as satisfactory as the free choice of whole corn did for group 1. Moreover, group 3, which received both the free choice of whole wheat and coarsely ground wheat instead of bran and middlings amounting to 42 per cent of the total feed intake, was also satisfactory.

Ration 4 was designed to avoid the need and expense of using milk products for the growth of chickens indoors. Oats were also omitted from this ration, and this omission made the percentage of corn correspondingly higher. Although the rate of growth of Leghorn and Rhode Island Red pullets in group 4 was a little less than for the other groups, it appears from these tests that satisfactory results can be expected from ration 4 when milk products are either unavailable or too expensive for economical use. It is believed that this ration would have been improved by the use of 20 per cent whole oats instead of that amount of ground corn. The whole oats—mash mixture without milk products could then be expected to yield results comparable to those secured with the other four rations.

In this experiment with rations for growth of chickens indoors, the free choice of whole wheat was as satisfactory as the free choice of whole corn. Moreover, the ration with the free choice of whole wheat instead of whole corn and the use of coarsely ground wheat instead of bran and middlings (in which the whole and ground wheat made up 42 per cent of total feed intake) was also satisfactory. Although the rate and economy of growth of group 3 without oats were comparable to those of the other groups, there was loss of birds from cannibalism, which made this ration less desirable than the rations containing whole oats. There was also a loss of birds from cannibalism in group 4, which received no oats, whereas there was no trouble from cannibalism in the other groups, 1, 2, and 5, which received the whole oats—mash mixtures. The Station has found the whole oats—mash mixture (20 per cent of which is whole oats) not only a preventive of feather picking and cannibalism, but also the most satisfactory way to feed whole oats, either to growing birds or to layers.

Despite the wide variation of the five rations and methods of feeding employed in this experiment, all yielded comparable results. It would seem, then, that the poultry raiser could make his choice on the basis of cost and availability of ingredients, provided 20 per cent of oats was used to replace that amount of ground corn in rations 3 and 4 to aid in the prevention of feather picking and cannibalism.

THE HOME APPLE ORCHARD

C. W. ELLENWOOD

Production of apples in Ohio in more recent years has been largely from commercial orchards. However, there still are many family or home orchards of 50 trees or less which are capable of producing enough apples to supply the needs of a family. Curtailment of transportation facilities has given impetus to the planting of new, as well as the rejuvenation of old, noncommercial orchards. Long-time variety and cultural trials at the Ohio Agricultural Experiment Station and observations made by Experiment Station horticulturists over the State provide the basis for the following recommendations relating to the planting and care of home apple orchards.

CHOICE OF VARIETIES

Proper selection of varieties is perhaps the most important factor in the success of the home orchard. So far as possible, home growers should choose varieties which require a minimum of spraying. Varieties which ripen during the summer or early fall generally require less spraying than late winter varieties and are, on the whole, more serviceable for the home orchard. The indulgence of personal preferences for varieties regardless of their commercial value makes the list of varieties for home use differ from the commercial list.

The following varieties, given in the approximate order of their ripening, are suggested for the home orchard in Ohio.

Yellow Transparent is one of the best varieties for home use. It comes into production at an early age. Ripening early in the season, beginning about the middle of July, this variety can be grown with fewer applications of spray material than most varieties. It is excellent for culinary uses and is especially desirable for home canning.

Lodi is a week later than Yellow Transparent and is very similar in appearance. It is good for culinary uses.

Melba, ripening at Wooster in early August, is the earliest really good variety for eating out-of-hand. It is a seedling of McIntosh and is somewhat like that variety in quality.

Battle is a comparatively new variety suggested for planting for home use instead of Oldenburg (Duchess). Battle is a seedling of Wealthy and is just as good as Wealthy for culinary uses.

Benoni is too small for commercial planting, but it is one of the really worth-while varieties for the home orchard. It is very good for dessert uses.

Chenango Strawberry, a Sheepnose type of variety, is strikingly colored but is too tender for shipping. It can be used in the home orchard.

Gravenstein is one of the finest late summer varieties for culinary uses, and it is also acceptable for eating out-of-hand.

Summer Rambo ripens in early September in the region of Wooster. It is much larger than Rambo and is good for both dessert and culinary uses.

Wealthy is one of the standard varieties for Ohio. It is better for cooking than eating out-of-hand. It is a good variety for early September.

Mother, a variety which ripens about September 15, is suggested for home use because of its high quality for both dessert and culinary uses.

The foregoing varieties can be grown with a fair degree of success even though spraying is discontinued by mid-June. The varieties which ripen later in the year generally require one or more applications in July.

Where winter varieties are desired, the following are suggested:

McIntosh is ready for picking about September 20 at Wooster. Its season extends through October and November. It is very high in quality but is extremely susceptible to apple scab.

Grimes Golden is a popular yellow variety good for all purposes through October and November.

Jonathan is a bright red apple, good for cooking and acceptable for dessert to those who like a snappy, juicy apple. Its season is October 1 to December 15.

Delicious is a highly flavored apple, especially preferred by those who like a mild apple. It is useful for salads but is not a good variety for culinary uses. Probably Richared and Starking, red strains of Delicious, are preferable. Delicious is essentially a cold storage variety if it is to be kept later than December 15.

Northern Spy comes into bearing rather tardily, but there is no better winter variety for cooking, and its spicy flavor makes an appeal to many people for dessert uses. It is deserving of a place in the home orchard. Red Spy is probably preferable to the regular Northern Spy.

Golden Delicious is another yellow variety, resembling Grimes in color and in quality. It is a midwinter variety but requires care in growing and handling in storage to avoid shriveling. It is excellent both for cooking and for eating out-of-hand.

Rome Beauty is one of the dependable winter varieties. It blossoms late, and this late blossoming provides some degree of insurance against spring frost injury. Although not as high in quality as most of the other varieties in this list, it is suggested for the home orchard because of its general dependability.

Stayman probably rates first place among the late winter varieties for Ohio. It is excellent for all uses. The trees come into bearing early and are productive. Blaxtayman and Staymared are two of the good red strains of this variety.

TABLE 1.—Number of days from full bloom to first picking at Wooster

10-year average, 1930-1939

Variety	Number of days	Variety	Number of days
Yellow Transparent	65	Jonathan	151
Lodi	81	Delicious	154
Melba	92	Golden Delicious	163
Wealthy	112	Rome Beauty	167
McIntosh	129	Stayman Winesap	168
Grimes	147		

SITE FOR THE ORCHARD

Ordinarily the choice of a site for the home orchard is more restricted than that for a commercial planting. The home orchard is generally situated near the farm buildings, regardless of the adaptability of the location for an orchard. It should be kept in mind that the two most important considerations in selecting an orchard site in Ohio are: freedom from frost, and good soil. Generally, it will be found that the higher elevations in any community are the freest from frost. Well drained, fertile soil which permits the trees to root deep is best for orchards.

NURSERY STOCK

Either 1- or 2-year-old apple trees can be planted. Regardless of age, they should be well-grown trees and at least medium in height and diameter. Apple trees can be planted either in the late fall or early spring. Fall planting is generally better for home orchards, because there is usually more time available on the average farm in late October or early November than in April.

PRUNING YOUNG TREES

Excessive pruning should be avoided in the early years, but the scaffold limbs should be chosen during the first 5 or 6 years. Scaffold limbs having wide angles are less apt to break when fruit bearing starts than those with sharp angles. Young trees should be examined annually, and broken or diseased branches removed. A minimum amount of pruning, but protection of the main scaffold branches, is recommended. Heading back is rarely required the first 10 years.

FERTILIZING YOUNG TREES

An annual application of sulfate of ammonia, cyanamid, or nitrate of soda, when available, in the amount of approximately one-fourth pound for each year of the tree's age, is advisable. This fertilizer is scattered on top of the ground in a circle around the tree early in the spring. Manure can be substituted for a fertilizer. A complete fertilizer similar to that used on grain crops, spread over the entire area of the orchard at the rate of 300 pounds per acre, is advised.

SPRAYING

The spraying required on young trees depends upon the amount of disease and insects present. Spray programs for varying conditions are covered in Ohio Agricultural Experiment Station Bulletin 599. From one to four applications, depending upon seasonal conditions, are required for trees under bearing age.

Plans for spraying or dusting must always be considered in planting an orchard. Unless this is done, the trees and the fruit are very apt to become a nuisance on the general farm or around a town lot.

Providing the spraying equipment is usually the most difficult requirement to meet in growing apples in the home orchard. Hand sprayers or hand dusters are available which can be used satisfactorily in caring for trees up to 10 or 12 years old. Power sprayers are expensive and can scarcely be justified for individuals

who have fewer than 50 trees. In some instances combination vegetable, potato, and fruit tree sprayers can be profitably installed. Under other circumstances, neighbors may find it advantageous to own a sprayer jointly. In a few favored communities, men who do custom spraying satisfactorily provide the machinery for applying spray material. Regardless of how the work is to be done, it cannot be overemphasized that apples must be sprayed or dusted to keep the trees in good vigor and to produce good fruit.

REJUVENATION OF OLD ORCHARDS

There are many old apple trees in small orchards which will respond to rejuvenation and provide enough fruit for family use. Generally the first task is pruning out the dead wood and removing the unproductive branches on the inside of the trees. Not infrequently these older trees are too high for effective spraying, and picking is also difficult on such trees. For such trees, heading back to within 18 or 20 feet of the ground is advisable. Where such heading back entails the removal of large branches, there may be some danger of injuring the tree, but since these old trees are of little value if left unpruned, there is little chance for actual loss to the owner. Pruning of this type can be done anytime during the late winter or early spring. After they are properly pruned, these trees require thorough spraying. A program of fertilization should also be instituted.

The extent to which old orchards can be rejuvenated can be determined only by a study of the individual trees, but generally, neglected trees more than 35 years old are of doubtful value for rejuvenation purposes.

CRAB APPLES

There are two crab apples which supply the demand for this fruit in the average home: Dolgo, which ripens in early August, and Hyslop, ripening about September 15.

GROWTH-PROMOTING CHEMICALS IMPROVE GREENHOUSE TOMATO PRODUCTION

FREEMAN S. HOWLETT

Pronounced improvement in greenhouse tomato production has resulted from the application of chemicals to tomato flowers in experiments conducted at the Ohio Agricultural Experiment Station. The work, initiated in 1938, was originally designed to ascertain the conditions necessary for production of the maximum number of seedless fruits, but it soon became evident that these chemical growth substances might be even more valuable in supplementing pollination and flower fertilization.

Within recent years it has become increasingly evident that performance of the operation involved in pollination by no means ensures actual transference of the pollen. Furthermore, even if pollination is accomplished, pollen germination may not take place, pollen tube

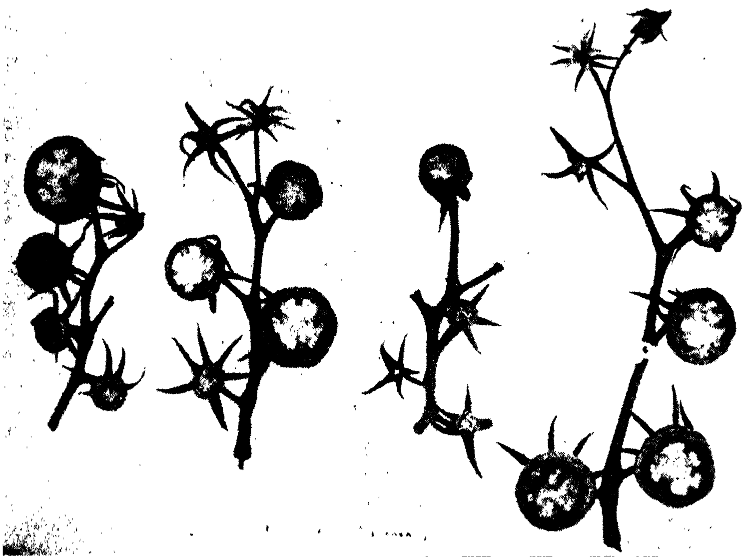

Fig. 1.—Typical clusters showing both failure of flowers to develop into fruits and failure of fruits to develop sufficient gelatinous pulp within the locules or seed cavities

Left to right—first cluster, second cluster, both on one plant; first cluster, second cluster, both on another plant

This situation is typical of vigorously growing plants supplied with considerable nitrogen and at least moderate light. Lack of effective pollination rather than pollen sterility was the factor involved in preventing fruit setting and proper fruit development in these clusters.

growth may be restricted, or fertilization may not ensue. In consequence, flowers may fail to develop into fruits; fruits may be small in size; or they may not be satisfactorily filled with the gelatinous pulp characteristic of fruits of the highest dessert quality. This condition is often characteristic of fruits developing from flowers of the spring crop growing during the period from January to April, when the days are relatively short and the light intensity low (fig. 1).

Because this condition and resulting economic losses are current in greenhouse tomato culture, the procedure employed to induce seedless fruits has been studied with the purpose of adapting it to improving fruit production. Results of experiments utilizing chemicals in this manner have been reported in part (1, 2, 3), but this paper presents further data.

METHOD OF EXPERIMENT

Tomato plants used in this work have been grown in the Experiment Station greenhouses during all seasons of the year. Part of the plants have been grown in 10- to 12-inch pots, and a considerable number have been planted in ground beds. The flowers of various clusters have been treated with the chemicals following pollination in the usual manner, and the results have been compared with those obtained from pollinated but untreated flowers. Only four flowers of a cluster were utilized, since this number permits alternation of treated with untreated flowers. For example, on the first plant the first and third flowers of a given cluster were pollinated, and the second and fourth flowers were pollinated and treated. On the second plant the order was reversed, and on the third the original order was repeated. Because of this arrangement more confidence can be placed in small differences between treated and untreated flowers.

The data taken include the percentage of flowers developing into mature fruits, average size of mature fruits, and proportion of fruits developing blossom-end rot. The amount of gelatinous pulp developing within the seed-containing cavities has been noted.

RESULTS

A portion of the work already published (2, 3) involved treatment of the flowers of the first two clusters of the spring crop in two representative greenhouses in northern Ohio. The treatment resulted in a distinct improvement in fruit set in all flowers of the first cluster and in the first flower of the second cluster in both houses. The improvement in set was greater in the greenhouse in which the flowers opened earlier. Furthermore, the earlier maturity of the fruits and their greater size, particularly during the first 2 weeks of harvesting, were outstanding (fig. 2). The seed cavities were well filled with gelatinous pulp despite the frequent absence of all seeds in

1. Howlett, Freeman S. 1941. Effect of indolebutyric acid upon tomato fruit set and development. Proc. Amer. Soc. Hort. Sci. 39: 217-227.

2. Howlett, Freeman S. 1941. Use of chemicals to stimulate fruitfulness in tomatoes. Proc. Veg. Growers Assoc. of Amer. for 1941: 203-214.

3. Howlett, Freeman S. 1942. Fruit set and development from pollinated tomato flowers treated with indolebutyric acid. Proc. Amer. Soc. Hort. Sci. 41: 277-281.

some fruits. The improvement in these respects was also greater in the earliest treated flowers, since light conditions were more unfavorable in March than in April. With advance in the season and more effective pollination, greater fertilization and embryonic development resulted, with consequent development of fruits satisfactorily filled with gelatinous pulp. The flowers were pollinated by the growers in the customary manner. The treatment was applied by the writer every fourth day during the blooming of these first two clusters.

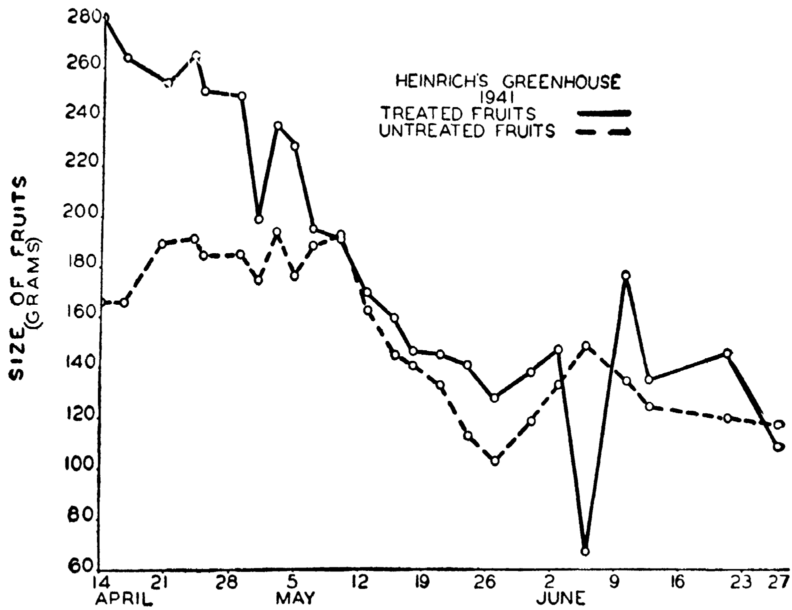

Fig. 2.—Size of fruits developing from pollinated (broken line) and pollinated and treated (solid line) flowers in a commercial greenhouse in northern Ohio. Fruits only from first and second clusters

Note wide disparity in size of fruits during April. Treated fruits ripened earlier, in part because of the rapid acceleration in growth after treatment of the flowers.

The results obtained at Wooster during 1941 and 1942 are presented in part in table 1. All the flowers except those of series I, 1942, were of the Globe (strain A) variety. Those of series I, 1942, comprised the Rutgers and Indiana Baltimore varieties. The flowers were carefully pollinated, and indolebutyric acid was applied as a spray in a liquid emulsion. As is indicated, not all clusters were pollinated and treated; on certain clusters seedless fruits were produced, and the data from these will be presented elsewhere.

TABLE 1.—Effect of treating pollinated tomato flowers with indolebutyric acid at various seasons of the year

Cluster order	Period of pollination and treatment	Self-pollinated flowers			Flowers pollinated and treated with 0.3 per cent indolebutyric acid emulsion		
		Number of flowers treated	Per cent setting fruit	Average weight of fruit (oz.)	Number of flowers treated	Per cent setting fruit	Average weight of fruit (oz.)
			Series IV, 1941				
1	Mar. 12-28.......	183	97.8	6.6	183	98.4	4.8
2	Mar. 24-Apr. 2...	184	93.5	6.6	175	96.6	7.3
5	Apr. 13-30.......	87	77.0	5.9	82	78.0	6.0
			Series V, 1941				
1	Mar. 25-Apr. 4...	95	97.9	6.0	87	98.9	7.8
2	Mar. 31-Apr. 8...	75	96.0	6.6	67	94.0	8.2
			Series VI, 1941				
1	Aug. 23-Sept. 3..	136	78.7	4.4	142	98.6	3.7
6	Sept. 24-Oct. 8...	143	79.7	5.0	143	81.1	5.8
			Series VIII, 1941				
1	Sept. 12-Oct. 2...	78	96.2	5.5	77	100.0	6.2
4	Oct. 9-Nov. 6....	83	80.7	5.3	66	98.5	6.5
5	Oct. 21-Nov. 21..	107	50.5	3.5	61	85.2	4.8
			eries IX, 1941				
2	Oct. 13-Nov. 21..	196	71.6	4.8	270	75.6	5.1
			Series I, 1942				
4	May 19-June 16..	216	81.9	6.2	100	91.0	5.9
5	May 28-June 22..	216	75.0	6.4	177	88.7	5.9
6	June 3-June 26...	161	66.5	5.5	75	82.7	5.2
7	June 10-July 6...	146	71.9	5.5	65	76.9	5.0

The results shown in table 1 may be summarized as follows:

1. The percentages of untreated flowers developing into fruits in the first cluster of the plants of series IV, V, and VIII were very high, and there was, therefore, no improvement following application of the chemical.

2. The percentage of flowers setting fruit was not improved by treatment in the second cluster of series IV, V, and IX.

3. On the other hand, the set was distinctly improved in the first cluster of series VI and in the fourth and fifth clusters of series VIII and series I (1942). It was improved in the fifth cluster of series VIII but not in the comparable cluster of series IV. Similar improvement was noted in cluster six of series I but not in cluster six of series VI.

4. In some instances fruit size was increased by the treatment even though no increase in fruit set had been obtained. This improvement was outstanding in certain clusters, such as cluster 2, series IV; clusters 1 and 2, series V; and all clusters of series VIII. In several instances the fruits from treated flowers were smaller, but this condition is not to

be expected except where the improvement in fruit set due to treatment results in an outstanding increase in number of fruits to a cluster.

5. These data definitely substantiate the conclusion that indolebutyric acid will not improve the set and size of fruits under all conditions. The extent of improvement following treatment depends upon the effectiveness of pollination, viability of the pollen, and amount of pollen tube growth, fertilization, and embryonic development resulting. The greatest improvement thus occurs under conditions of low light intensity and during the period of relatively short days characteristic of the season from January to March.

As a result of work carried out during the last 2 years, another important conclusion has been noted. These chemicals do not prevent the dropping of flowers on the upper clusters, such as the fourth to sixth, when such occurs as a result of heavy set below (fig. 3). The work indicates that these chemicals cannot replace carbohydrates and other materials which are formed in the leaves and are withdrawn very extensively during the development of the fruits on the lower and earliest opening clusters.

Since these chemicals have resulted in such marked improvement in fruit set, size, and quality during certain critical periods in the greenhouse, it is now recommended that they be given a limited trial in commercial greenhouses. However, their use should be restricted to the first and second clusters of the spring crop at present. Obviously, no grower should use indolebutyric acid if the flowers of these clusters are setting heavily, that is, if no difficulty is obtained in bringing about thorough pollination and fertilization with high seed content. However, where environmental

Fig. 3.—Tomato plant showing failure of fruit setting in the fourth (and possibly the fifth) cluster in consequence of a heavy set on clusters one to three. Application of a growth-promoting chemical to these clusters should not be expected to result in fruit setting. The result will depend upon the extent of withdrawal of food materials from the plants by the developing fruits.

conditions have resulted in flowers with pollen of low viability (fig. 4), in flowers with fasciated, flattened, or elongated styles which are pollinated only with difficulty, this chemical might well be employed in order to supplement pollination and fertilization, with pronounced success.

Fig. 4.—Flowers of the first cluster which will be improved in set by application of the growth-promoting chemical

The first two flowers, left to right, have sterile pollen and would not otherwise set fruit. The flower on the right has an elongated style, which makes pollination difficult.

Since the use of indolebutyric acid in a limited way is recommended, the necessary information for its use is presented in the remaining portion of this article.

CHEMICALS TO USE

Various chemicals have been utilized as the effective agents, but indolebutyric acid has been superior to nearly all others in the experiments at Wooster when all considerations are taken into account. The fact has been established that growth-promoting chemicals are not equally effective in improving fruit set, increasing fruit size, or stimulating development of the gelatinous pulp. For example, indoleacetic acid is practically equal to indolebutyric acid in improving fruit set, but not in improving fruit size. Beta naphthoxyacetic acid is not equal to indolebutyric acid in stimulating development of the gelatinous pulp within the fruits, for a greater proportion of the fruits produced during the period from January to March are not well filled. With more favorable light conditions the differences between these two chemicals become less pronounced.

METHODS OF APPLICATION

The effective chemicals can be applied in paste or liquid form. The liquid form is preferable, because the material may thus be applied as a spray, and the flowers left intact. When the paste is applied, the style must be severed at its base and the

material applied to the cut end. Applying the chemical to the stigma is not satisfactory. Application of the standard lanolin emulsion is preferable under present conditions, since it can be sprayed at the base of the stamens, whereupon it seeps in around the ovary (fig. 5).

Fig. 5.—Flower in full bloom, with arrow showing exact location where the effective chemical is to be placed with the atomizer

Application of the material in dust form to tomato flowers has been ineffective. Application of chemicals in gaseous form has not been successful as yet, since the effects of such applications cannot be controlled, and where they have been used, they have not resulted in satisfactory filling out of the fruits.

PREPARATION OF PASTE AND EMULSION

The paste or emulsion can be made without difficulty, provided the ingredients and a small druggist's scale or balance are available. It is suggested that those who do not have the necessary scales have a druggist measure out the ingredients in the proper amounts.

DIRECTIONS FOR PASTE

The preferable concentration is 0.3 per cent indolebutyric acid in lanolin.

Materials required are hydrous lanolin (lanum), a little grain, or ethyl, alcohol, and indolebutyric acid. The lanolin can be obtained from a drug supply house and is inexpensive. Indolebutyric acid can be obtained from Merck & Company, Rahway, N. J.

One gram of indolebutyric acid is sufficient for 333 grams, or 0.75 pound, of lanolin. Since only a very small amount of paste is placed on the cut end of the style, only 1 or 2 ounces should be made up at a time. One ounce of paste will require 1⅓ grains of indolebutyric acid.

The lanolin is heated until it is melted, while the indolebutyric acid is dissolved in 2 to 3 milliliters of ethyl alcohol. This solution is added to the melted lanolin and stirred for 5 minutes. The mixture is also stirred while the paste is hardening. The material should be left exposed to the air for several hours to allow the alcohol to evaporate, but it should be kept in the refrigerator when not in use.

DIRECTIONS FOR EMULSION

The preferable concentration of indolebutyric acid in the lanolin emulsion is 0.2 to 0.3 per cent.

Materials to make 300 milliliters of 0.3 per cent emulsion are:

- 16 grams of lanolin (hydrous)
- 3 grams of stearic acid
- 1.06 grams (1.1 milliliter) of triethanolamine
- 0.9 gram of indolebutyric acid
- Distilled water to make the emulsion up to a volume of 300 milliliters

The stearic acid can be obtained from any chemical supply house, and triethanolamine, from the Eastman

Kodak Co. or from the Carbide & Carbon Chemicals Corp., 30 East 42nd St., New York City. Both are inexpensive.

The emulsion is made as follows:

1. The stearic acid and lanolin are heated together until the mixture is melted (70-80° C.), and then stirred well.

2. The indolebutyric acid is dissolved in the triethanolamine by heating the mixture to 70-80° C., and the solution is then added to the stearic acid and lanolin. The resulting mixture should be stirred well.

3. 40 milliliters of distilled water are heated to the same temperature and added slowly to the mixture, which is stirred vigorously until the emulsion is produced.

4. Sufficient water is added slowly to the emulsion to bring it to volume (300 milliliters). The emulsion is stirred vigorously by hand or put in a Waring blender.

Growers can make the emulsion by using the following proportions and standard measuring spoons:

7 teaspoonfuls of melted lanolin (hydrous)
3 teaspoonfuls of stearic acid
¼ teaspoonful of triethanolamine
1 gram of indolebutyric acid
Water (distilled) to make 1 pint of emulsion

These ingredients will make 1 pint of emulsion of a concentration slightly over 0.2 per cent.

The procedure is as follows:

1. The stearic acid is placed in the melted lanolin which has been heated to 158-176° F. (70-80° C.) and stirred well.

2. The indolebutyric acid is dissolved in the triethanolamine by heating the mixture to 158-176° F., and the solution is then added to the stearic acid and lanolin. The resulting mixture is stirred well.

3. Six tablespoonfuls of distilled water are heated to the same temperature and added slowly to the mixture, which is stirred vigorously until the emulsion is produced.

4. Sufficient cool distilled water is added slowly to the emulsion to bring it up to 1 pint. The emulsion is stirred vigorously by hand.

The emulsion may partially break when the dilution is made, but with subsequent vigorous stirring it will be re-formed.

This emulsion may partly separate on standing, but vigorous shaking will induce re-emulsification without injuring the effectiveness of the chemical. The emulsion will be alkaline at pH 7-8 when prepared. A slightly higher pH is not detrimental, but the emulsion may break at reactions below 7.

The directions given should be followed carefully to produce an emulsion with no small particles which will plug the orifice of the atomizer. The presence of such small particles does not seem to reduce the effectiveness of the chemical otherwise. The material should be kept in the refrigerator when not in use.

The atomizer employed with most success is known as Atlas atomizer No. 82, manufactured by the DeVilbiss Company (fig. 6). The atomizer should be cleaned after using.

This emulsion will result in a larger amount of blossom-end rot on treated fruits than occurs on untreated fruits when environmental conditions result in development of this disorder. Thus its use is not recommended above the third cluster in the spring crop. Study is being given at present with much success to other emulsions which will not accentuate the occurrence of this dis-

order. However, since the emulsion has not resulted in blossom-end rot in any greenhouse in northern Ohio when employed in the manner suggested, its use is recommended until the other emulsions can be perfected.

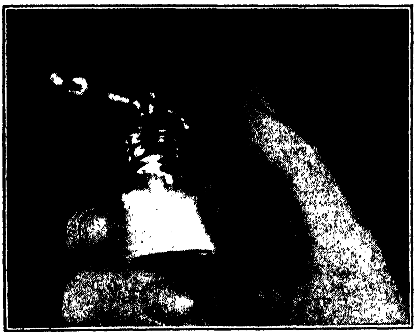

Fig. 6.—Atomizer employed in treating flowers. The atomizer shown contains the emulsion.

PROCEDURE TO FOLLOW IN TREATING FLOWERS

The flowers to be treated must reach full bloom if the maximum effect of the chemical is to be obtained. Flowers treated in the enlarged bud stage just previous to opening do not set as satisfactorily, and tne fruits when produced are not as well filled with gelatinous pulp.

It is recommended at present that flowers be pollinated in the usual manner before treatment. Undoubtedly, a large proportion of treated flowers of the first cluster would develop into fruits even if not pollinated, but at the present time, pollination should not be eliminated. Following pollination, and before the petals close around the stamens, a point indicating the end of full bloom (fig. 7), a small amount of the emulsion is sprayed at the base of the stamens. The flower is left intact; no clipping of the style or emasculation is necessary.

The flowers may be treated at any time while the stamens are exposed, or during a period lasting 3 or 4 days, depending upon weather conditions. After the first treatment, the plants should be examined every fourth day, and all open flowers should be treated. No flower requires a second treatment. Flowers may be treated with some success if they are past full bloom, provided they are not about to fall. The writer has stimulated fruit development by treating flowers after the petals have fallen (fig. 8). Such fruits frequently contain no seeds, a condition indicating lack of pollination, and usually they are not as well filled with gelatinous pulp as those treated during bloom. They may also fail to become as large.

GENERAL CONCLUSION

The treatment of tomato flowers which have been subjected to pollination to increase fruit set, size, and

Fig. 7.—Flower at end of full bloom. In some instances flowers will drop shortly after this stage is attained. Note elongated style.

quality is still in the experimental stage. However, such favorable results have been obtained in the greenhouses of the Ohio Agricultural Experiment Station at Wooster and in several commercial greenhouses in northern Ohio (fig. 9) that it is recommended that growers employ

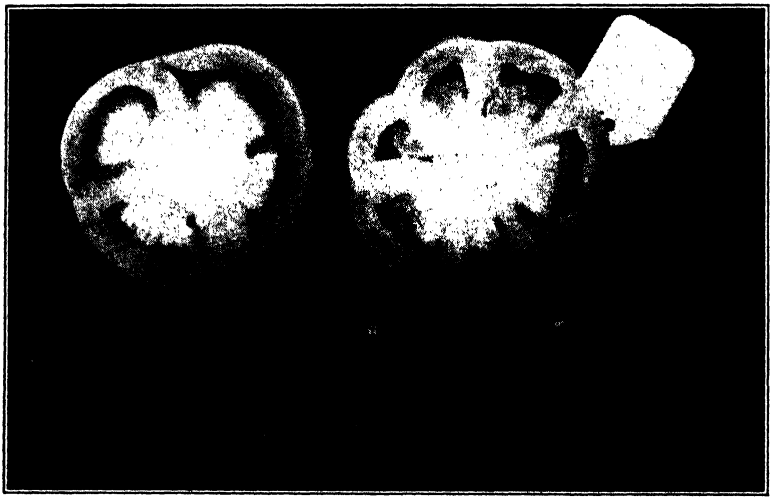

Fig. 8.—Effect of treating drop with indolebutyric acid after petals and stamens have dried. All flowers in same cluster

Upper—treated
Lower—untreated

indolebutyric acid in a limited way. At present, however, it should be used only when environmental conditions within the greenhouse have resulted in pollen of low viability, in flowers with elongated, fasciated, or flattened styles, or in other conditions where benefit might be expected from supplementing pollination and fertilization of flowers.

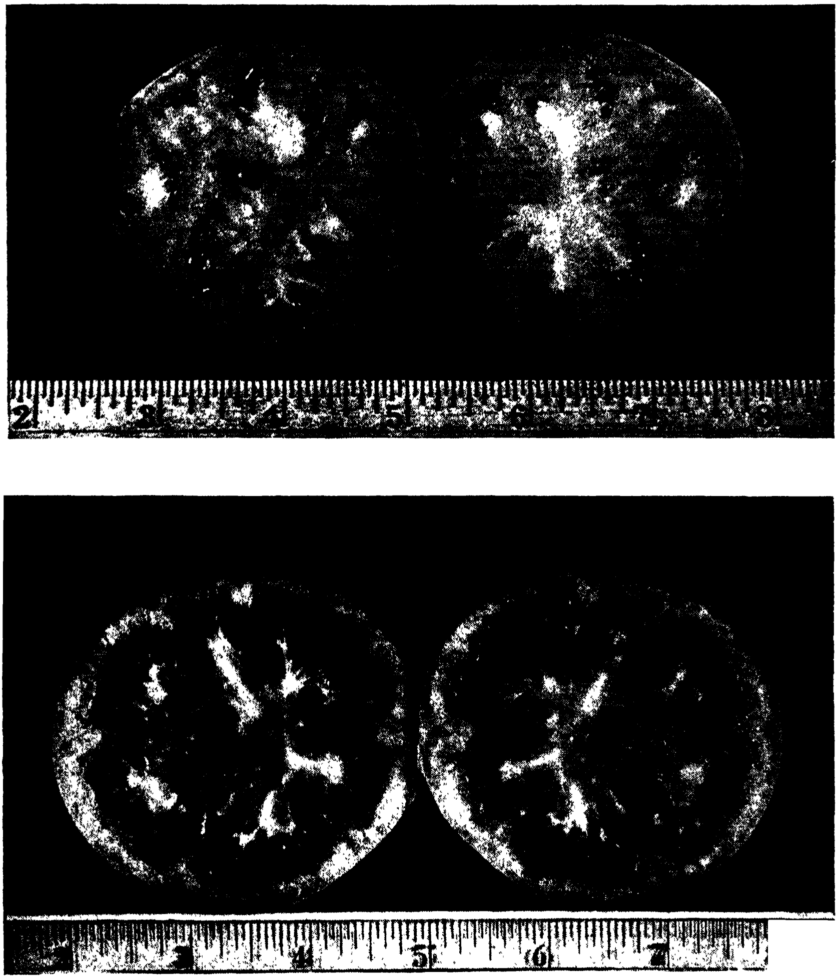

Fig. 9.—Fruits from pollinated flowers, untreated and treated with indolebutyric acid, showing the comparatively greater development of gelatinous pulp within the seed cavities of those treated

Upper—untreated
Lower—treated

DRYING STORED SHELLED CORN BY FORCED VENTILATION

G. R. SHIER, R. C. MILLER, AND W. A. JUNNILA

The corn shock and the ventilated corn crib, the two old farm methods of drying corn on the ear in Ohio during autumn and winter, may now be assisted, if not replaced, by a third method, in which the corn is shelled as soon as possible and then dried with forced-air ventilation. The shelled corn storage method has extensive practical possibilities for several good reasons, according to results of work carried on by the Agricultural Engineering Department, which has been studying methods of storing new high moisture content shelled corn.

The rapid development of corn pickers and cylinder shellers and the preliminary development of field shellers have created a need for facilities to store and dry high moisture content shelled corn. Shelled corn is easier to protect from rodents and storm than ear corn and requires only half the storage space. Also, since the cob of high moisture content corn contains a high percentage, as well as a large amount, of moisture,[1] early shelling and drying by forced ventilation eliminate the problem of drying the cobs. Shelled corn can be stored in tight bins, which better protect the corn from insects and provide better conditions for use of fumigation to kill insects that do get in.

Probably the most important reason for interest in the storage of shelled corn in ventilated bins is that it should do much to improve the quality of the 14 to 45 per cent of the harvested Ohio corn crop that is not marketable each year.[2]

STUDIES IN 1940-1942

Most of the work has involved the use of small blowers to force air through a ventilated floor up into the corn. Both heated and unheated air have been used. Findings to date indicate that artificial heat is usually necessary in order to get the corn dried down to less than 14 per cent moisture during the months of November to April.

UNHEATED AIR MAY DRY CORN IN AUTUMN AND SPRING

In September and October and again in April and May, periods of weather often occur that are suitable to remove moisture rapidly and to dry the corn down to below 14 per cent moisture content. Suitable weather is characterized by warm, sunny, breezy days and cool nights.[3] Good corn drying weather is recognized as the kind that makes the surface of the ground dry out rapidly so that fields can be worked.

COOL CORN USUALLY MEANS GOOD CORN

Corn does not spoil if kept reasonably cool. An air temperature of 55° F. did not spoil corn in the tests even when the corn was ventilated for several days with air saturated with moisture. To keep high mois-

[1]See Table I, page 5, of mimeographed extension publication, "Seed Corn Drying," ----, --, --. J. Miller and G. R. Shier, Department of Agricultural Engineering, The Ohio State University.

[2]From Ohio Agricultural Experiment Station Bulletin 460.

[3]See chart on page 176, Bimonthly Bulletin 219, November-December, 1942, for characteristic drying weather.

ture shelled corn from harvest time until April, it should be chilled by occasionally blowing cold air through it. Best times for cooling corn usually are at night or early in the morning. When shelled corn in a tight bin is once chilled, it stays cool for long periods during the fall, winter, and spring, because normal temperatures during those seasons are low.

WHY AND WHEN TO VENTILATE CORN

Whenever suitable weather occurs, the corn can be ventilated continuously night and day to remove moisture. It is important that the ventilation be stopped late at night or early in the morning so that the corn will remain as cool as possible when left in the bin. Running the ventilation system during the warm part of the day and then shutting it off is ineffective and may be harmful. Heat is needed to remove moisture, and if artificial heat is not added to the air, it is necessary to use the natural heat during the middle of the day to heat up the corn and then to remove that heat during the cool of the evening and night by ventilating. As the heat is removed, moisture is also liberated and carried away. Consequently, ventilation should be continuous day and night during warm sunny days and cool nights. The greater the difference between day and night temperatures, the faster the corn will lose moisture.

WHEN AND HOW TO DRY CORN WITH ARTIFICIAL HEAT

Keeping the corn cool during the winter and drying it out in the spring are practical measures for those who need not dry corn to grind during the winter, but poultrymen, dairymen, and hog feeders who grind corn need dry grain to prevent musty feed. To dry corn during the winter when the weather is cold and damp, it is necessary to heat the air enough to raise its temperature about 20 or 25° F. That much or more heat will dry the corn down to moisture contents around 9 or 10 per cent, making it dry enough to keep safely when ground even though it may absorb a little moisture from the damp air or from other feed materials.

SOYBEANS MAY BE DRIED IN SAME MANNER AS SHELLED CORN

Although no tests have been run on soybeans, it seems safe to assume that ventilating the beans in a similar manner will prevent moisture damage.

AMOUNT OF AIR REQUIRED TO DRY SHELLED CORN

Air flow of 1 to 3 cubic feet per minute per bushel of shelled corn gave good results in the tests. The higher amount is more desirable, as it permits rapid cooling and, during suitable weather, more rapid drying of the grain.

FANS OR BLOWERS THAT MAY BE USED FOR FORCED VENTILATION

Small multivane blowers driven by quarter-horsepower motors are ample for bins up to 200 or 300 bushels in size. A blower constructed from plywood was built and used successfully in the spring of 1942 on 300 bushels of shelled corn.[4] The materials were inexpensive, but construction of the blower wheel required the use of a power-driven table saw to cut out the grooves into which the blades fit.

[4]Blueprints for the plywood fan can be obtained by requesting your county agricultural extension agent to secure plan 09402 through his regular plan service.

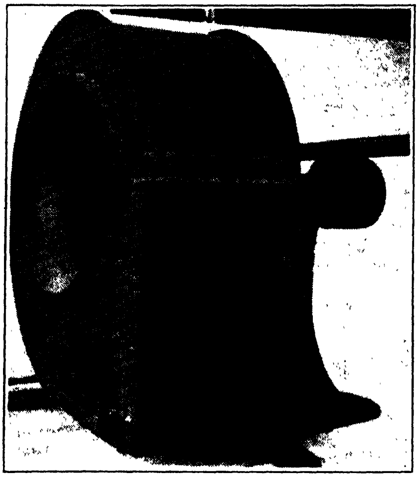

Fig. 1.—Low-speed multivane blower of a type suitable for grain ventilation work

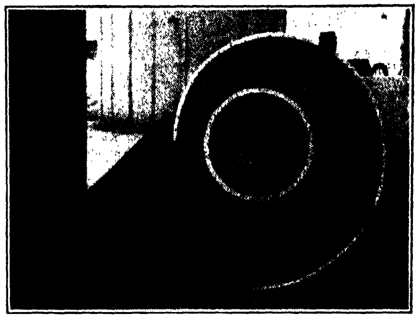

Fig. 2.—Plywood blower connected to round metal crib. Air is forced in at lower left under the ventilated floor and then up through the shelled corn. This equipment could also be useful for high-moisture soybeans. Note the screen over the fan inlet to keep out rats, mice, birds, and the like.

The plywood fan could easily be constructed in school shops or local mill-working shops. The fan runs at the comparatively low speeds below 570 r. p. m., and, consequently, slight imperfections in the balance do not cause noticeable vibration when the blower is operating

The actual r. p. m. needed depends upon the air pressure or resistance against which the fan must work. When the plywood fan is not working against air pressure, a speed of 375 r. p. m. is all a ¼-h. p. motor will safely handle, but as pressure is built up, more speed can be handled by a ¼-h. p. motor. When the fan was tested, the ¼-h. p. motor handled the fan at 570 r. p. m. operating against an air pressure of ⅝-inch[5] resistance. At this r. p. m., it delivered 600 cubic feet per minute at ⅝-inch resistance, compared with about 2,000 cubic feet per minute at 375 r. p. m. when blowing air into an open room where there was no resistance or back pressure. The nature of the fan is such that operated at 570 r. p.m. when blowing air into an open room, it would require a ½-h. p. motor and still not blow much over 2,000 cubic feet of air per minute. If the air pressure cannot be measured, it would be safer to use a ½-h. p. motor and avoid the danger of burning out a ¼-h. p. motor if the fan speed is set at more than 375 r. p. m.

For any given speed (r.p.m.), the greater the air resistance on the fan, the lower the power consumption. This condition is the opposite of what most people expect, since it is natural to associate high resistance with high power consumption.

AIR FORCED THROUGH FLOOR UPWARD THROUGH CORN

All the bins used have had perforated floors which were built above the original floor. The air was

[5]The ⅝-inch resistance means a pressure equal to the weight of a ⅝-inch layer of water.

forced in under the perforated floor and up into the corn. Several types of floors were tried, including hardware cloth, perforated metal, and perforated plywood. The hardware cloth gave good ventilation, but it was least satisfactory, because of the ease with which it is damaged by shoveling. It should be laid over slats spaced an inch or two apart.

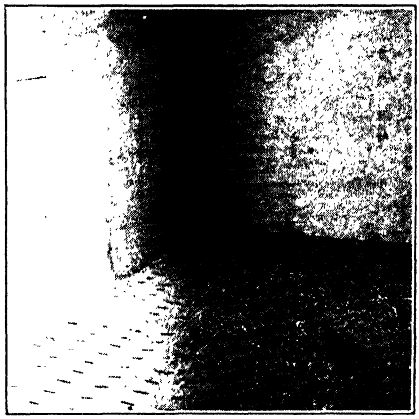

Fig. 4.—Perforated metal floor used in part of the tests

It has given good service although designed originally for the storage of ear corn. Slits are ¼ inch wide, and a small amount of shelled corn fell through. A somewhat similar floor of plywood with ⅛-inch slits is being used in a round metal bin.

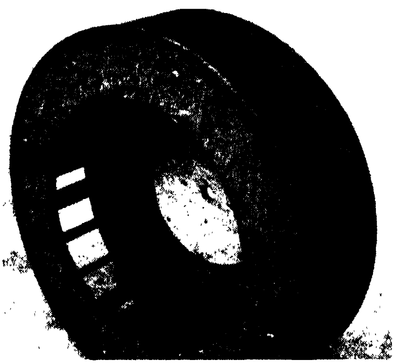

Fig. 3.—Blower wheel constructed from plywood

The vanes are of ¼-inch plywood, and the wheel is ½-inch plywood. The vanes are glued into grooves cut out of the inner wheel surfaces on a table saw. The glue holds the wheel together, but four tie bolts were placed through it as an added safety feature.

The perforated metal floor has given good results, and the plywood appears to be satisfactory, although it has not been used long enough to determine its possibilities.

WOOD SLAT FLOOR MAY BE USED

Slats made of 1 by 2 - inch or 1 by 3 - inch boards laid with a ⅛-inch crack between each slat are suitable for corn and soybeans and make a durable floor. Beveling the boards slightly so that the cracks are wider on the underside than on top will reduce clogging by dirt, broken grains, and trash.

POWER CONSUMPTION LOW

Approximately ½ kilowatt hour per bushel was used in cooling and drying a 300-bushel bin of shelled corn with the home-constructed plywood blower. Some commercial blowers are more efficient and would use less power.

LOSSES IN SILAGE-MAKING[1]

A. E. PERKINS

Losses of 10 to 20 per cent or more of the dry matter of the ensiled crop, exclusive of visible spoilage at the top or elsewhere, have commonly been reported by investigators of silage problems. Losses of such magnitude have been difficult to explain on the basis of known chemical changes occurring in the ensiled material. They have also been difficult to harmonize with the observed efficiency of silage as a feed for livestock.

A certain amount of loss is encountered in any method of handling or storing crops, and the various methods of crop storage may be considered more or less in competition as to which can show the smallest loss. It is, therefore, important that a method of crop storage which is so convenient and satisfactory in most respects as silage-making should not be charged with huge losses which are due largely to hidden errors and faulty methods of analysis.

Farm silos or experimental silos of comparable size are rarely completely emptied at one time. Removal of the silage usually goes on during a feeding period of several months; hence, it is seldom practicable to make a direct comparison of the total weights of crop and silage. When such a comparison is attempted by totaling the weights of the silage as removed for feeding, the total weight so obtained is always much less than the weight of the crop ensiled. A considerable but unknown proportion of this apparent loss of weight is doubtless due to the continuous exposure of a moist surface of silage to evaporation during the entire feeding period. This explanation is supported by certain studies reported on smaller silos from which the entire contents have been removed and weighed at one time. Such studies have shown weight losses decidedly smaller than the commonly observed values. Slow removal and the movement of soluble materials within the silage make accurate sampling difficult and uncertain.

Most attempts to study the loss of dry matter as distinct from the total loss of weight have likewise indicated losses much greater than could be explained on the basis of changes known to occur in the process. The method of water or dry matter determination almost universally used in such studies has been to dry weighed portions of the material to constant weight at approximately the boiling temperature of water. The dried residue has been considered as dry matter and the loss of weight as water.

A considerable increase in the apparent water content of many experimental silages over that of the corresponding crop was observed by the application of this commonly accepted method of analysis. Often no water addition from outside sources was possible. These circumstances

[1]This material is being presented more formally in the Journal of Dairy Science under the title, "Dry matter determination in green plant material and in silage."

suggested to the writer that this customary method of dry matter determination was probably at fault. Accordingly, this method, in which the loss of weight on drying is considered as water, was compared with a newer but also officially approved method in which the moisture or water is recovered and measured by volume. On most fresh plant material, including the crops ordinarily ensiled, results by the two methods were in good agreement.

However, when silage made from the same or similar crops was studied by each of these methods, the results were quite different, as shown in table 1. A higher water, thus a lower dry matter, content was shown in each case by the usual loss of weight on drying method than by the other method, in which the water itself is recovered and measured. Some kinds of green plant material which possess a particularly strong odor behave somewhat as does silage in this respect.

TABLE 1.—Water determination in silage by oven-drying and by toluene distillation

Kind of silage	Water as determined by—	
	Loss of weight on oven-drying	Direct measurement after distillation
	Per cent	Per cent
Corn silage, sample 1	71.8	69.7
Corn silage, sample 2	71.1	70.0
Corn silage, sample 3	72.9	71.0
Mixed legume, untreated	73.6	71.8
Mixed legume plus corn, sample 1	72.2	70.0
Mixed legume plus corn, sample 2	71.1	70.0
Alfalfa, dry, fine-cut	56.7	56.0
Alfalfa, wet, fine-cut	72.7	70.0
Timothy, sample 1	77.7	76.0
Timothy, sample 2	78.3	75.7
Timothy, sample 3	77.2	75.0

The explanation of this difference is that volatile acids and sometimes other volatile substances are formed during the silage-making process. Some of these are driven off as gases during the drying and thus are included as water in the usual method of analysis. The distillation type of method, on the other hand, measures only the water actually recovered in liquid form, while the volatile products other than water which occur in the silage are considered as part of the dry matter. Some, and probably most, of these volatile materials possess value as feeds. For this reason, it would seem that the latter, or distillation type, method for water determination gives more nearly correct results on silage. In calculation of results by either method when the amount of water is stated as a percentage of the weight of the silage, the per cent dry matter can be found by subtracting the per cent water from 100, or vice versa.

The observed differences in the dry matter content of silage as determined by these two methods ranged from a minimum of 0.7 per cent to a maximum of 2.7 per cent with the silages studied. These probably do not represent the extreme values in either direction which would result from a more extensive study. Stated as percentages of the wet silage,

these differences in observed dry matter content do not seem particularly impressive. However, when considered as percentages of the dry matter itself, they seem to assume added significance. The reduction in calculated dry matter loss resulting from the use of the newer method instead of that commonly employed would range from about 3 per cent to a maximum of more than 10 per cent of the total dry matter of the silage.

The degree of difference between the two methods is not the same for all the silages studied, a result which suggests that different amounts of volatile products are formed in silage, depending on the crop ensiled and the conditions under which the silage is made. However, a detailed statement regarding the effect of these various influences is not possible at present.

Widespread application of the toluene distillation or similar method of water determination to silage should result in marked reduction in the estimated losses in silage-making. It should also call for a revision of existing statements regarding the average composition and comparative feeding value of silage as determined by analysis.

The differences observed in this study are sufficient to account for a major share of the hitherto unexplainable losses of dry matter commonly reported in silage studies.

PRELIMINARY RESULTS ON THE CONTROL OF TOMATO ANTHRACNOSE

J. D. WILSON

Anthracnose of tomato, *Colletotrichum phomoides* (Sacc.) Chester, is the most destructive disease of ripe tomatoes grown in Ohio for the canning trade. The economic loss to tomato growers from it is exceeded only by that resulting from attacks of alternaria and septoria leaf spots. The possible occurrence of anthracnose fruit rot in a particular field is very unpredictable, but it is likely to be severe in many fields in any Ohio locality when the August and early September rainfall is excessive (1). The disease usually appears in a few fields in comparatively dry years. It is most frequently found on light soils (sandy loams and the like) in Ohio (2) but may occur in any field when rainfall is excessive, as it was in northwestern Ohio in late August and early September of 1942. Samson and Thomas (3) found the disease most common in infertile and poorly drained portions of Indiana fields. Fruits which ripen on plants that have lost a large percentage of their leaves from storm or disease effects (4) seem to be particularly susceptible to anthracnose. Most of

1. Chupp, C. 1937. The effect of temperature and moisture on vegetable diseases in New York State in 1937. Plant Disease Reporter 21: 320-321.
2. Davidson, R. S. 1942. Anthracnose of tomato. Ohio State Univ. Thesis.
3. Samson, R. W., and H. R. Thomas. 1940. Tomato diseases in Indiana. Ind. Agr. Exp. Sta. Cir. 257, 1-35.
4. Hunter, H. A. 1933. Diseases of canning crops in Maryland in 1933. Plant Disease Reporter 17: 183.

the conditions that favor excessive defoliation of tomato vines also encourage the development and spread of fruit rots.

The causal organism of anthracnose apparently overwinters in diseased refuse about the tomato field, but information concerning the manner and time of infection and the incubation period is meager. Samson and Thomas (3) believe the fungus to be present in most Indiana fields, and Miller (5) and Tisdale (6) state that it can be seed borne. Ramsey and Link (7), as well as many others, consider it chiefly a disease of the ripe fruit, but it seems likely that initial infections must occur some time ahead of the beginning of ripening in many instances, although the fungus develops slowly in green fruit. Tisdale (6) found that the fungus began to grow in the usual way when inoculated into green fruits but that its growth was later checked and the entrance wound corked over. The fungus was only dormant, however, and began to grow again as the fruit ripened.

Anthracnose first appears as small, circular, translucent, slightly sunken spots on the ripe or nearly ripe fruit. The spots are usually most numerous on the stylar end, possibly because that portion of the fruit is most likely to be in contact with the soil. The lesions increase in size rapidly after their initial appearance, and a hamper of apparently disease-free fruit sorted from others in a heavily infested field during the picking operation may contain many fruits with numerous and comparatively large lesions 24 hours later. The zonated appearance of the lesions is brought about by the formation of rings of dark-colored fruiting bodies of the fungus during periods which alternate with others of purely vegetative development in which the growing fungus is lighter in color. The lesions continue to remain roughly circular and somewhat sunken as they enlarge to a maximum size of 1 inch or more, and several may coalesce to cover a considerable portion of the fruit (fig. 1). The fungus may penetrate deeply or remain close to the surface, but in any event, the loss to the grower because of a reduction in grade is serious and to the canner because of the extra work necessary to remove the fruit blemishes and the added possibility that the mold count of the finished product will be abnormally high.

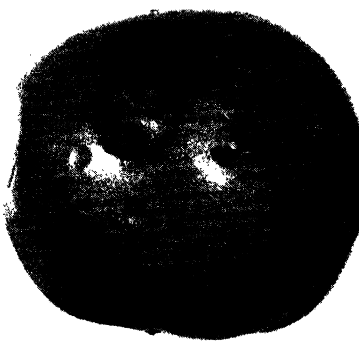

Fig. 1.—Target-like spots caused by anthracnose of tomatoes

It has frequently been observed that tomato anthracnose is less common on sprayed plants than on untreated ones in the same group of experimental plots (2, 3, 8, 9) even

5. Miller, J. H. 1936. Tomato disease notes for Georgia for 1936. Plant Disease Reporter 20: 351.
6. Tisdale, W. H. 1915. Tomato anthracnoses. Univ. Wis. Thesis.
7. Ramsey, G. B., and J. K. K. Link. 1932. Market diseases of fruits and vegetables. U. S. D. A. Misc. Pub. 121, 1-44.
8. Wilson, J. D. 1939. New equipment and new materials for controlling vegetable diseases. Proc. Ohio Veg. and Potato Growers Assoc. 24: 110-134.
9. Wilson, J. D. 1942. The fixed coppers on vegetables in 1941 with special references to the influence of supplemental materials. Proc. Ohio Veg. and Potato Growers Assoc. 27: 61-75.

though the sprays have not been timed or applied for the purpose of controlling that particular disease. In 1941, anthracnose caused considerable loss in a number of fields used for experimental purposes. In most of these fields, this disease was observed to be less severe in treated than in untreated plots. The frequency and severity with which the disease has appeared during the last few years in Ohio, together with the likelihood that it could be greatly reduced by a properly timed spray program, made it seem desirable to apply certain spray materials for the purpose of controlling anthracnose in 1942.

In 1938 and again in 1941, it was observed in early September that many of the tomatoes in experimental spray plots at Wooster were affected with anthracnose. The percentage of diseased fruits was determined for each treatment. The data are presented in table 1. Bordeaux mixture reduced the disease to a considerable extent both years. Bordeaux discolors the fruit, however, is hard to remove, and is not commonly recommended for general use on tomatoes because of various injurious effects. Some of the fixed coppers, as well as Fermate, were also quite effective in 1941.

TABLE 1.—Control of tomato anthracnose resulting from the use of various spray materials at Wooster in 1938 and 1941

Treatment	Percentage of ripe fruits showing anthracnose on—	
	Sept. 2, 1938	Sept. 3, 1941
Check (no treatment)	40.0	14.0
Basicop (4-100)	32.2	8.2
Cuprocide (2⅔-100)	32.0	4.7
Copper A (4-100)	13.0	5.4
Bordeaux (8-8-100)	13.0	2.7
Fermate (3-100)	....	1.8

Cuprocide was known from previous experiments to aid in improving fruit grade. Therefore, this material and Fermate were used in a staggered spray schedule for the control of anthracnose in 1942. A hybrid in which the San Marzano variety was one parent, and which was known to be very susceptible to anthracnose, was used. The first spray date was July 22, and the last was September 20. Plots were in triplicate, and each group of three was treated three times. The spray schedule used is illustrated in table 2.

Fermate gave considerably better control than Cuprocide. The early schedules gave by far the best results although no fruits were picked until September 12 and few lesions were found on fruits before September 4. This result suggests the possibility that the original infections must have occurred in early August at the latest. Two rather unusual factors were involved, however. The season, especially the month of August, was extremely dry, and this particular tomato variety, although very susceptible to anthracnose, clings to the

vine in a ripe condition longer without collapse or disintegration than most commercial varieties. For these reasons, conditions relative to infection and the later development of the individual lesions may have been somewhat unusual.

Anthracnose was observed in 1942 in several fields around Bowling Green where the rainfall was extremely heavy between August 15 and September 20. In one experimental field, a picking made on September 29 showed 21.1 per cent of the fruits from untreated plants to be affected with anthracnose, whereas only 11.4 per cent of those from the average of five copper-treated plots were diseased. In another field, the percentages of diseased fruits on September 24 were 23.4, 22.3, and 15.6 from plots receiving no treatment, and from plots dusted with fixed coppers and Fermate, respectively. The first field showed a considerable reduction in anthracnose from the use of a fixed copper (COC-S), but in the second, Fermate was again considerably more effective in reducing infection than were the fixed coppers.

On the basis of data obtained so far in experimental trials, Fermate (ferric dimethyldithiocarbamate) seems to offer considerable promise in the control of tomato anthracnose. It should be used in at least three applications at 10-day intervals, with the first sometime between August 1 and 10. Fermate is not so efficient, however, as some of the copper-containing materials in the control of defoliation due to alternaria and septoria leaf spots. For this reason, the manner in which it should be fitted into a general control schedule remains to be determined. It seems likely that spraying will be more effective than dusting for the control of a fruit rot, and for that reason, the whole control program may be influenced by this consideration in areas where anthracnose is a common source of loss. Future trials will involve the use of several fungicides in several different application schedules on at least two tomato varieties.

TABLE 2.—Influence of spray schedule timing on anthracnose control at Wooster in 1942

Date of treatment	Average percentage of ripe fruits showing anthracnose in pickings on Sept. 12, 21, and 29	
	Fermate (3-100)	Cuprocide (3-100)
Check (no treatment)	44.2	44.2
Sprayed July 22, Aug. 1 and 11	4.1	19.9
Aug. 1, 11, and 21	5.3	26.9
Aug. 11, 21, and 31	9.3	29.8
Aug. 21 and 31 and Sept. 10	12.5	28.3
Aug. 31, Sept. 10 and 20	36.5	37.7

INFLUENCE OF SOIL TYPE AND TEMPERATURE ON RATE OF ESCAPE OF CHLOROPICRIN

J. D. WILSON

Chloropicrin is comparatively ineffective as a soil disinfectant at temperatures below 60 to 65° F. (16-18° C.). This material, as well as various others, including formaldehyde, that are used to eliminate undesirable organisms, must be allowed to escape from the soil before seeds or plants are introduced if injury is to be avoided. The rate at which volatile disinfectants, such as chloropicrin and formaldehyde, escape from the soil is regulated to a considerable degree by such factors as soil type, degree of packing, temperature, and moisture content. Wilson and Tilford (1) found that warm, dry soils of light texture could be safely planted more quickly than cold, wet ones of heavier nature, after treatment with formaldehyde dust, and it seems likely that the same is true for those treated with chloropicrin.

The experiments discussed were performed in an effort to determine how much time should be allowed to elapse between treatment of the soil with chloropicrin and the setting of plants. Four soil types—Wooster silt loam prepared as compost, Brookston clay loam, Dunkirk sandy loam, and muck—were used, and these were maintained at six different temperatures (12, 16, 20, 24, 28, and 32° C., or 54 to 90° F.) in a series of temperature tanks of the Wisconsin type. Each tank accommodated a battery of eight cans, two of each soil type. Weighed quantities of each soil type at approximately its optimum moisture content were placed in cans about 8 inches in diameter and 12 inches deep. The moisture contents were maintained by daily weighings. After the soil temperatures had become stable at each of the points in the series, 2 cc. of chloropicrin were placed at the center of the soil mass at a depth of 4 inches by means of a burette and a funnel.

Two days after the chloropicrin was added to the soil, five tomato seedlings were placed in each can. At the end of 2 more days (4 days after original treatment), these plants were removed from the soil and examined. All were dead at all temperatures. Another lot of seedlings was set with as little disturbance of the soil mass as possible, and another 2-day period was allowed to pass, after which the procedure was repeated. Examinations and plantings were then made at two 3-day intervals, and these were followed by four at 4-day intervals (eight in all) until all plants finally survived even at 12° C. (54° F.). This complete survival occurred for the planting made 28 days after the date of treatment. Tomato plants were started at 4-day intervals so that plants of approximately the same age could be used throughout the experiment. The soil and temperature series was first treated on October 27, and a second test was started late in November 1941. Data representing the averages of the two trials were then used in calculating the values given in tables 1, 2, and 3.

1. Wilson, J. D., and P. E. Tilford. 1933. The use of formaldehyde dust in growing seedlings. Ohio Agr. Exp. Sta. Bull. 520, 1-40.

The plants showed various types or degrees of injury when subjected to the action of chloropicrin, and their condition after each planting was noted in four classifications. If the chloropicrin was still very strong in the soil, all parts of the plant (roots, stem, and leaves) were flaccid, brown, and water-soaked 2 or 3 days after they were placed in the soil. A slightly lesser degree of injury resulted in a collapse of the roots and that portion of the stem below ground, while the tops remained turgid for 2 or 3 days. If all but a trace of the chloropicrin had escaped at the time the plants were set, only the roots were affected. The plants then produced new roots at the base of the stem, and recovery became complete at a later date. Finally, when all or practically all the chloropicrin had disappeared (as well as the odor of it), the test plants were unaffected, and the setting date for that group of plants was recorded as the one of complete freedom from chloropicrin. These four degrees of plant condition were given score values of 0 (all parts dead), 33 (roots and belowground stems dead), 67 (only roots dead and new ones forming), and 100 (no injury). These values were averaged to obtain injury scores for each soil type at each temperature.

The data of table 1 illustrate the influence of soil temperature on the rate of escape of chloropicrin from treated soils. The graduated degree of injury to test plants of tomato is indicated by the variable score values. At the end of 6 days after treatment, the cans of soil held at 32° C. still contained enough chloropicrin to cause considerable injury to tomato transplants. The score of 61 indicates that some plants (those in the silt or sandy loams) were uninjured but that others (those in muck) were either killed or severely injured, since a score of 67 represents root injury followed by a later production of new ones. Thus, the safe planting dates of soils, regardless of type, are 9, 12, 16, 20, 24, and 28 days after treatment at 32, 28, 24, 20, 16, and 12° C., respectively. Injury was still severe in the group of cans held at 12° C. even 9 days after treatment, whereas those held at 32° C. were completely free of chloropicrin at that time.

TABLE 1.—Effect of temperature on the average survival score of tomato plants placed in soils treated with chloropicrin

Temperature of soil in °C.	Days after treatment with chloropicrin								
	2	4	6	9	12	16	20	24	28
32	0	39	61	100	......	......	......	....	....
28	0	30	50	85	100	......	......	......	....
24	0	24	40	75	90	100	..	......	....
20	0	6	25	50	69	94	100	......	....
16	0	0	23	46	58	74	92	100	....
12	0	0	0	0	46	56	66	88	100

The date of freedom from injury to tomato plants after treatment of the soil with chloropicrin, as indicated in table 1, is somewhat misleading, since the soil may have become free at any time between that date and that of the previous examination. The data of table 2 are presented to show the period in which the safety point must have fallen. These data also illustrate still further the relationship between soil temperature and type and rate of escape of chloropicrin. All soil types were free after 9 days at 32° C. (90° F.), and Wooster silt loam was also free at that time at 28° C. All were free after 12 days at 24° C. except muck, and that required somewhere between 12 and 16 days. Muck was also behind the other types at 20 and 16° C., and at 12° C., muck and sandy loam were slower in becoming free than silt loam and clay loam.

TABLE 2.—Influence of soil type and temperature on the time necessary after treatment before a soil became sufficiently free of chloropicrin that it might be planted without danger of injury to tomato plants

Soil type	Period (in days) after treatment during which soils became free of chloropicrin at temperatures (°C.) of—					
	32	28	24	20	16	12
Silt loam	6-9	6-9	9-12	12-16	16-20	2-24
Sandy loam	6-9	9-12	9-12	12-16	16-20	24-28
Clay loam	6-9	9-12	9-12	12-16	16-20	20-24
Muck	6-9	9-12	12-16	16-20	20-24	24-28

The data of table 3 show the effect of soil type on the rate of escape of chloropicrin. The values given in the table represent averages of all six temperatures used. The Wooster silt loam compost lost its chloropicrin faster than the other three soil types. Muck lost it more slowly than the others, as would be expected because of its high content of moisture and organic matter. The sandy and clay loams were very similar in their behavior, especially in the later stages. This similarity was rather unexpected, but later examination of the sandy loam showed the particular lot used to contain a considerable quantity of clay particles.

TABLE 3.—Effect of soil type on survival score of tomato plants set at successively longer intervals after treatment

Values are averages of those for six temperatures.

Soil type	Days after treatment with chloropicrin								
	2	4	6	9	12	16	20	24	28
Silt loam	0	27	41	68	86	90	96	100	100
Sandy loam	0	16	35	61	79	89	94	97	100
Clay loam	0	8	33	60	79	88	92	97	100
Muck	0	9	22	49	64	76	86	92	100

CONCLUSIONS

Chloropicrin escapes more rapidly from warm soils than cold ones and more quickly from light soils than heavy ones or from muck. A period of approximately 9 days should be allowed to elapse between treatment of soils at 32° C. (90° F.) and the setting of plants if injury is to be avoided. With soils at 24° C. (75° F.), which is near the usual temperature condition, the interval between treatment and planting should be about 12 days, except for muck, for which 16 days should be allowed. At 16° C. (61° F.), which is the lowest temperature at which treatment should be attempted, the intervening period should be 20 days unless the soil is stirred vigorously every day or two during the latter part of the period. Muck soil holds chloropicrin more securely and thus for a longer period than do most of the mineral soils.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

From January to October, 1942, there was a 26 per cent rise in Ohio farm wages; during the same period there was a rise of 17 per cent in the prices farmers received for farm products. From January to September, Ohio industrial payrolls rose 23 per cent.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913........	102	....	101	101	104	100	105	101
1914........	99	....	100	101	102	102	105	109
1915........	102	....	105	98	103	107	106	112
1916........	125	....	124	118	113	113	121	123
1917........	172	....	149	175	140	119	182	201
1918........	192	....	176	202	175	131	203	243
1919........	202	....	202	213	204	135	218	270
1920........	225	....	201	211	236	159	212	230
1921........	142	....	152	125	164	134	132	134
1922........	141	....	149	132	145	124	127	133
1923........	147	....	152	142	160	122	134	147
1924........	143	....	152	143	165	118	133	150
1925........	151	....	156	156	165	110	159	180
1926	146	....	155	145	170	105	155	183
1927........	139	....	153	139	173	99	147	171
1928........	141	....	155	149	169	96	154	163
1929........	139	....	154	146	169	94	151	172
1930........	126	....	146	126	154	90	128	142
1931........	107	84	126	87	120	82	89	105
1932........	95	58	108	65	92	70	63	77
1933........	96	61	108	70	74	59	69	87
1934........	110	77	122	90	77	63	85	102
1935........	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937........	126	120	131	121	118	75	128	164
1938........	115	87	123	95	117	74	103	140
1939........	113	103	121	93	117	76	95	140
1940........	114	117	122	98	116	77	99	146
1941........	127	170	131	122	138	80	121	185
1941								
January....	118	135	123	104	117	....	106	139
February..	118	143	123	103	....	....	104	130
March.....	119	149	123	103	....	80	106	138
April.......	121	157	124	110	133	....	116	163
May.......	124	165	125	112	....	....	121	173
June.	127	179	126	118	....	....	127	173
July..	130	180	129	125	151	....	136	206
August ..	132	182	131	131	....	....	135	214
September.	134	183	133	139	....	....	138	220
October....	135	187	136	139	155	....	133	219
November.	135	186	141	135	....	....	136	222
December.	137	193	143	143	....	....	140	226
1942								
January....	140	192	146	149	153	....	141	201
February..	141	199	147	145	....	....	144	183
March....	142	208	150	146	....	89	146	208
April.	144	210	151	150	167	....	153	230
May.......	144	216	152	152	....	....	157	241
June.......	144	222	152	151	176	....	157	232
July..	144	230	152	154	179	....	159	237
August....	145	233	152	163	....	....	164	248
September.	145	237	153	163	....	....	161	268
October ...	146	....	154	169	193	....	165	290

*SOURCE: Bureau of Business Research, The Ohio State University.

BIMONTHLY BULLETIN

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MORE FOOD
FOR FREEDOM'S FIGHTERS
THROUGH RESEARCH

OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO, U. S. A.

YOUR AUTHORS

Batchelor

Dr. H. W. Batchelor, microbiologist in the Experiment Station's Agronomy Department, tells farmers how to get the most out of their crop residues and manure, and what supplemental fertilizing is necessary with each, valuable information in these times of fertilizer limitation. Before his article appeared in print, Dr. Batchelor had become Captain Batchelor, United States Army.

Hauck

C. W. Hauck, rural economist, has made a survey of the vital motor transport situation in the important fruit and vegetable market at Cleveland, Ohio. He offers the survey results, and some suggestions for bettering the situation.

Laurie

Since war brought a shortage of crude drugs to America, the Ohio Experiment Station has been developing ways of producing the needed drug plants here. Ways of producing and curing the important belladonna plant appear in this issue, the result of experiments by Alex Laurie and E. N. Stillings. A picture of Mr. Stillings at work with his plants appears in his article.

Sleesman

J. P. Sleesman of the Station's Entomology Department tells of his part in the search for onion varieties that will resist the attack of onion thrips, a damaging insect which is generally distributed in onion-growing sections.

Already familiar to readers of the Bimonthly Bulletin are authors Kennard, Wilson, Howlett, Ellenwood, and Falconer, who again offer information of use to the farmers of Ohio in this issue.

Dr. Leon Havis, who gives home gardeners tips on growing their own small fruits, has left Ohio to carry on his work in Washington, D. C.

Appearing in this issue's cover picture is no mere pose for Thomas E. Fowler. To be absolutely accurate, however, there should now be two stars in his window. Besides their recognized obligation to a Nation searching for new sources of food and fiber, Ohio Agricultural Experiment Station workers have a tremendous personal stake in this war effort. In addition to our fellow workers who have gone, our list of blue star fathers, wives, sisters, and brothers is long.

Our watchword—**Food For Freedom's Fighters!**

IN THIS ISSUE

SMALL FRUITS FOR THE HOME GARDEN

LEON HAVIS

During wartime, every garden ought to be as useful and productive of healthful foods as possible. Among such foods are fruits, which increase both the healthfulness and the palatability of meals. Most gardeners recognize the need for a continuous supply of fruits throughout the season for table use and usually make some effort to produce several different kinds. Small fruits, such as strawberries and raspberries, have several advantages for the home or Victory Garden. They come into bearing early, need little space, and usually require little or no spraying. Plants are not expensive and are often available from a local nursery. With a selection of several varieties and types of small fruits, the gardener can have fresh ripe fruit throughout most of the summer. Surplus berries can be made into jams and jellies, frozen, or otherwise preserved for winter use.

The small fruits are not difficult to grow, but successful production does require considerable planning and care. Perhaps no type of fruit is as responsive to attention, especially at certain periods, as berries. Conditions and practices necessary to securing highest possible returns from a small home fruit garden are outlined here. Considerable judgment is necessary, of course, in following these recommendations, as every garden is different, and any suggested treatment could not be perfectly applicable to each individual garden.

VARIETIES

Best small fruit varieties for the home garden are those that are dependable, of high quality, and relatively resistant to insects and diseases. A fairly high yielding variety is desirable, but yield can be partly sacrificed for quality and dependability in the home garden. In order to have ripe fruits throughout the season, it is necessary to choose varieties ripening over a long period.

STRAWBERRIES

Desirable strawberry varieties include such high-quality ones as Fairfax, Catskill, Chesapeake, and Redstar, which ripen in the order named and should furnish ripe berries for at least a month. Fairfax and Chesapeake are of the highest quality, but they usually do not yield as much as the other two. If a fall-, or everbearing, type is desired, Rockhill (Wayzata) is suggested. It yields a light crop in June, but most of the berries ripen during September. Fall-bearing strawberries are not high yielding, but they are sometimes prized in the home garden because of their ripening season.

RASPBERRIES

Latham is probably the most dependable red raspberry variety for Ohio. Its canes are vigorous and hardy to low temperatures, and its berries are large and of fair quality. Latham will resist the virus diseases well, but they spread easily from

Latham to susceptible varieties, such as the black and purple types. Where a succession of high-quality varieties is desired, the June, Taylor, and Indian Summer can be used. These varieties are all susceptible to mosaic, however, and require roguing each year to check the disease. June is an early variety. Taylor ripens with Latham but is of higher quality. Indian Summer bears a light crop very early in the spring and its main crop after September 15. Indian Summer lacks the size and firmness of the other varieties mentioned.

Bristol is the recommended black raspberry variety for the home garden. It is vigorous and productive, and its berries are large and of high quality.

Purple raspberries are sometimes desirable, especially for jam and for freezing. Sodus is the purple variety recommended. It is susceptible to mosaic and should, therefore, be at least 20 rods from Latham.

BLACKBERRIES

Blackberries are easy to grow, and their fruit, when fully ripe, is one of the best. The Eldorado variety is recommended.

DEWBERRIES AND BOYSENBERRIES

Dewberries and boysenberries are not hardy enough to withstand many Ohio winters. Since they require winter protection and trellising, and since their yields are often disappointing, the boysenberry and dewberry are not recommended extensively even for the home garden.

GRAPES

Concord (black), Delaware (red), and Niagara (white) are the grape varieties suggested for home planting. If a long ripening season is desired, Fredonia (black) and Portland (white) can be used, since they ripen relatively early.

CURRANTS AND GOOSEBERRIES

Because of its size, quality, and productiveness, the Red Lake currant is suggested.

Of the gooseberries, Poorman is probably the preferred and most dependable variety for the home orchard and garden.

BLUEBERRIES

Since blueberries require special soil treatment in most sections of Ohio, the gardener will probably want only a few plants. The plants are fairly expensive, also. In order to have a range in ripening, the following varieties are suggested, in the order in which they ripen: Cabot, Stanley, and Jersey.

NUMBER OF PLANTS NEEDED

The number of plants of each fruit type to obtain for the home garden obviously depends on the size of family, the family's food tastes, and the garden space available. Yields will depend very much on the care given the planting, as well as on seasonal conditions. As a guide, the following number of plants is suggested, with approximate yields to be expected from mature plants: strawberries, 150 plants—100 quarts; raspberries and blackberries, 60 plants—100 quarts; grapes, 10 vines—200 pounds; currants and gooseberries, 10 plants—25 quarts; blueberries, 12 plants—25 quarts. If a long picking season is desired, a selection of early and late varieties is made.

SOIL PREPARATION

The small fruits, with the exception of blueberries, grow best in a sandy loam or silt loam soil. The soil should be well drained, or the

plants are not likely to produce well and will be short-lived. If the soil has been fertilized properly for vegetables in previous years, it is not likely to need any commercial fertilizer before the plants are set. If the soil is low in fertility, an application of manure at the rate of 20 tons per acre, plowed into the soil, will be helpful. If manure is not available or is excessively expensive, a complete fertilizer, such as a 4-12-4 or 6-10-4, at the rate of about 600 pounds per acre, can be used. It should be applied after the soil has been plowed, but before disking. The soil is then thoroughly prepared before the plants are set.

Soil in which blueberries are to be grown requires special treatment in most sections of Ohio. At the Ohio Agricultural Experiment Station, on Wooster silt loam soil, a mixture of peat and topsoil around the plant roots has given best results. The mixture consisted of 3 gallons each of topsoil and wet peat. A hole was prepared large enough so that the 6 gallons of this mixture could be placed in it and tamped well around the plant roots as the plant was set out. Another successful treatment at the Experiment Station has been to plow into the soil 15 tons per acre of air-dry peat moss or sawdust before the plants are set out. The use of some material, such as sulfur, to raise the soil acidity is often recommended for blueberries, but on the basis of tests at Wooster, this practice seems questionable under most Ohio conditions. After blueberries become established, they are grown under a mulch of some such material as wheat straw, peat moss, or sawdust.

PLANTING

Most small fruit plants are inexpensive, and the gardener should obtain only the best. Usually, vigorous 1-year-old plants are preferable. Blueberry plants are fairly expensive, and either 2-year-old or 3-year-old plants are preferable for setting.

Small fruits can be set out in either late fall or early spring. There is some danger of winter injury if they are set in the fall, and, with certain soils, there may be considerable heaving. Strawberries set in the fall require mulching over two winters before they bear fruit. However, some fall-set plants often become well established during the early winter and are ready for an early start in the spring. Furthermore, there are few winters in Ohio which are severe enough to cause much damage to such plants as raspberries, blackberries, currants, and blueberries. Straw or some other such material can be placed around the plants to prevent heaving. Plants to be set in the spring should be planted just as soon as the soil can be prepared—this is very important.

In the home garden where space is at a premium, strawberries can be set 18 inches apart in rows 3½ feet apart. For the other small fruits, the rows can be set 6 feet apart. Raspberries are set about 2½ feet apart in the row; currants, gooseberries, and blueberries, about 5 feet. Grapes are set at least 7 feet apart.

Plants should be set in the soil to about the depth they were in the nursery, or slightly deeper. The growing point of the strawberry plant must not be covered with soil. When the plants are set, the soil is firmed around the roots, and if the soil is dry, water is poured around the base of the plants so that the soil is well soaked. It is essential that the plant roots never dry out either before or after planting.

When grapes are planted, they are cut back so that only two buds are

left. Currants, gooseberries, red raspberries, and blackberries have their canes cut back to about 8 inches at time of planting. If strawberry plants have a large number of leaves, the lower, or older, ones are removed.

CULTURE

Strawberries require cultivation throughout the growing season. Runners which set early in the season are more productive than those set later, and, therefore, early runner plant formation is to be encouraged. A 3-inch mulch of wheat straw or some such material is applied to strawberries during the latter part of November. This mulch is removed about April 15 and left between the rows. It is preferable to set out a new strawberry planting each year, or at least every 2 years, rather than to fruit the patch longer.

The other small fruits can be cultivated until about July 15, when a cover crop, such as rye, oats, or rye and vetch, can be sown between the rows. This treatment is especially desirable where there is danger of erosion. Instead of being cultivated and planted to cover crops, the planting can be mulched if mulch is available. Strawy manure can be used, and if it is, probably no additional fertilizer will be needed. If the straw is new and contains no manure, a fertilizer high in nitrogen should be applied.

Under a system of clean cultivation in a good garden soil which has been well manured, small fruits usually do not respond to additional fertilization. On soils of low fertility, however, it may be desirable to apply a commercial fertilizer, preferably one that is high in nitrogen. Poor plant growth and yellow foliage are indicators of low nitrogen fertility, although such conditions also occur under poor drainage and certain disease conditions.

PRUNING

Pruning of small fruits is not difficult, but it is one of the most necessary operations. The purpose of pruning is to make it possible for the plant to produce the maximum of high-quality fruit over a long period. Development of plant strength is an important consideration.

New black and purple raspberry and blackberry canes are topped or tipped back during early summer. Black raspberries are tipped back to a height of about 20 inches, and the purples and blackberries, to approximately 30 inches. Red raspberries are not tipped. In tipping, it is preferable to remove about 3 inches of the new growth. As soon as raspberries and blackberries have fruited, the old canes should be cut off near the ground level and removed. The new canes will produce the fruit for the next season.

During the dormant season, preferably in the early spring before growth has started, the lateral branches of black raspberries are cut back to about 8 inches. Branches of purple raspberries and blackberries are left 12 to 14 inches long. Red raspberries, which are not tipped in the summer, are pruned back lightly during the dormant season. If there is no trellis or stake to hold the canes upright, they should be cut back to about 3½ feet; otherwise little or no cutting back is necessary. The small, weak canes should be removed, and the row allowed to become not more than 18 inches wide.

Pruning of currants and gooseberries consists mainly in removing the older canes and leaving those which are 3 years old or younger. Any

weak or dead growth should also be removed. The pruning of these plants during the first 2 or 3 years should be only to thin out the weaker canes. Only about 10 canes per plant should be left.

Grapes should be trained to a 2- or 3-wire trellis or to a fence. It is important to remember that the fruit is borne only on shoots from canes of the previous season's growth. With vigorous plants, 40 to 50 buds distributed over 4 to 6 canes can be left for fruiting. If more wood is left, there will probably be a higher yield, but of smaller bunches and lower-quality fruit.

Pruning blueberries is mainly for the purpose of maintaining large berry size and plant vigor. The first 2 or 3 years, the plants require little or no pruning. Later pruning consists mainly in removal or cutting back of older canes and weak shoots through the plant. Increase in berry size can be obtained by heading back shoots on which there are a larger number of flower buds. This operation is especially necessary with certain varieties.

PROPAGATION

Strawberries are propagated from runner plants formed during the summer. Only new runner plants should be used for propagation, not the old or original plants which were first set out. Plants used for setting a new patch should be vigorous and well rooted.

The black, and most of the purple, raspberry varieties are propagated from tips. When the ends or tips of the lateral canes show a "rat tail" shape, usually in late August, the tips are ready for layering. The tips of the canes are covered with 2 or 3 inches of soil. The following spring, the rooted tips are ready for transplanting. Red raspberries and blackberries are propagated from suckers or shoots which arise from underground roots. These usually arise both in the original plant row and between rows. In late fall or early spring, they can easily be lifted with a spade and transplanted. It is preferable to move as many roots with the new plant as possible, and some soil, if convenient. Root cuttings can also be used for propagation of blackberries.

Grapes and currants are propagated from cuttings of the previous season's growth. Cuttings are made 8 to 10 inches in length and taken during the winter or early spring. Gooseberries are ordinarily propagated by mound layering. The home gardener, however, will find it more convenient to obtain 1- or 2-year-old plants directly from the nursery.

Blueberries are propagated from either hardwood or softwood cuttings, but they are not so easily rooted as grapes and currants, and it is better for the home gardener to obtain 2- or 3-year-old plants from a nursery which makes a specialty of propagating plants for growers.

HIGH POINTS IN INCREASED WARTIME POULTRY AND EGG PRODUCTION

D. C. KENNARD AND V. D. CHAMBERLIN

Poultry and egg production in 1943 involves many new or special considerations. In the first place, almost every poultryman is thinking in terms of increased production of poultry and eggs. Any expansion of the poultry enterprise calls for many new and special considerations, especially in view of the increased problems and difficulties sure to be encountered. Unless these matters receive timely consideration, an expansion of the poultry enterprise may not result in increased production of poultry and eggs.

The greatest liability or temptation in connection with an expansion of the poultry enterprise, and the most frequent cause of the losses or failures that too often follow, is the expansion of one phase of the poultry enterprise without due consideration or expansion of the other phases.

There are three primary phases in poultry and egg production which command their respective considerations:

1. Brooding—brooder houses, brooders, equipment, and range
2. Growing—range, colony houses, range shelters, and equipment
3. Laying—laying house and equipment

Suppose a poultryman, encouraged by last year's success or prompted by the war demand, decides to start more chicks in 1943. His first impulse and temptation may be simply to start more chicks with his present brooding equipment, without regard to losses from overcrowding. If he does, he will end up with less pullets than he had from a smaller number of chicks last year, and, moreover, these pullets will be of inferior quality.

Perhaps another poultryman, conscious from previous experience of the liabilities and losses to be expected from overcrowding chicks, provides the additional brooding equipment to accommodate the larger number of chicks but fails to expand his facilities for growing pullets. He succeeds with the first phase of his expansion program but fails with the growing pullets.

A third poultryman comes through the brooding and growing periods with too many pullets for his laying house. His desire to produce more eggs and his reluctance to sell the surplus pullets get the better of his judgment. Thus he chances to ignore one of the most exacting requirements of good poultry husbandry and crowds the pullets into a laying house too small for the number to be accommodated. His failure from loss of valuable pullets and loss of egg production, which are sure to follow, may be the greatest of all.

The fourth poultryman decides to expand the laying facilities without due regard to brooding and growing facilities. With the completion of his new laying house, he proceeds to start correspondingly more chicks with no additional brooding and growing equipment. His incoordinate expansion is doomed to failure because of inadequate facilities for chicks and growing pullets. Ob-

viously, poultrymen need to be familiar with and to heed the old saying, "No chain is stronger than its weakest link."

The four typical examples of how a poultryman may expand one or two phases of his poultry enterprise without giving due consideration to other phases equally essential have been cited in detail because each of the four represents tens of thousands of poultrymen who make incoordinate expansions of their poultry enterprise each year and fail to produce more poultry and eggs. Obviously, such needless failures and the tremendous losses to the poultry industry and to the country as a whole should, by all possible means, be kept at a minimum in 1943 and for the duration. Here, indeed, is where poultry raisers can help win the battle on the home front.

To avoid the liabilities of incoordinate expansion of the poultry enterprise, it is necessary to be familiar with the housing requirements of chicks, growing pullets, and layers, and to adhere closely to these requirements. This information has been charted so that the poultry raiser can tell at a glance how many chicks, growing pullets, and layers his equipment will properly accommodate. The chart also indicates the housing requirements for a given number of chicks, growing pullets, or layers. The housing capacity requirements for chicks and growing pullets are based upon a 10 by 12-foot colony brooder house and a 10 by 12-foot range shelter, because these units are used by the majority of poultry raisers in Ohio. When smaller brooder houses or range shelters are used, a corresponding decrease in the number of chicks and growing pullets will be necessary. However, the number of chicks to be brooded in one unit should never exceed 300 to 350, regardless of the larger size or capacity rating of the hover and the larger size of the brooder house or brooding compartment.

When the numbers of unsexed Leghorn chicks indicated in the chart are started, the Leghorn cockerels must be removed when 4 weeks of age; otherwise, only half the number of chicks indicated should be started. Likewise, it is necessary to remove the heavier breed cockerels just as soon as they can be detected, if the ills and losses from overcrowding are to be avoided.

It is evident from the chart that the range shelter is valuable for use in connection with the colony brooder house when the chicks are on range after the first 2 to 3 weeks. When a fresh range well isolated from older birds is used, the range method is generally the best and surest procedure for raising high-quality pullets comparatively free from coccidiosis and associated diseases.

Although great liabilities attend incoordinate expansion, it is seldom that the poultryman can expand all three phases of his poultry enterprise at once, because of the labor and capital requirements. There are ways, however, by which the poultryman can successfully expand his poultry enterprise one phase at a time.

To begin with, he can raise two to three times as many chicks with his present brooding equipment by brooding two or three times a year instead of once. To house the additional chickens will call for inexpensive range shelters, which can be made of wood on the farm without the use of wire or sheet metal. With sufficiently increased range shelter accommodations and plenty of range,

the poultry raiser can double his production of ready-to-lay pullets in 1943. He can then either sell his surplus pullets or provide suitable additional laying quarters for them in the barn or some other farm building.

Another poultryman, with no increased production of pullets, may be in a position to expand his facilities for layers in 1943, especially where suitable barn or other building space can be adapted for the purpose. He can then coordinately expand into his new laying quarters by keeping over all his select yearling layers another year, or, by all-night light during the fall and winter months and good feeding and management, get as many fall and winter eggs as possible from the hens and sell them when necessary to make room for the September-hatched pullets, which should start to lay about the first of March.

September-hatched pullets raised in colony houses on range can be expected to make better quality pullet layers than those raised indoors. The September-hatched pullets will generally need to be moved from the range to suitable winter quarters the first part of December. If suitable quarters in the barn or other buildings are available, the hens need not be sold until February. If, on the other hand, it is necessary to move the September-hatched pullets directly to their permanent laying quarters, then it will be necessary to dispose of the hens the latter part of November to make room for the new crop of pullets. In this connection, it should be emphasized that owing to their susceptibility to colds, roup, and bronchitis when in too close contact with older birds, fall-hatched pullets should be housed separately from older birds if at all possible.

Many poultry raisers will expand their poultry enterprises in keeping with the increased wartime needs for more poultry and eggs. It has been indicated how the liabilities of incoordinate expansion may defeat the whole object of expansion. To aid poultry raisers in avoiding the disappointments or failures too often due to incoordinate expansion of the poultry enterprise, the safe number of chicks to start in a 10 by 12-foot colony brooder house and the housing requirements of growing pullets and layers have been indicated in the accompanying chart.

Although expansion of one phase of the poultry enterprise without due consideration or expansion of the other equally important phases may prove a hazardous undertaking, it is recognized that few poultrymen find it practicable to expand all three phases of their enterprise at once. Suggestions have been made as to how expansion of one or the other phases of the poultry enterprise can be made without involving the liabilities of incoordinated expansion. For example, the number of ready-to-lay pullets can be doubled by brooding two or three times a year instead of once with the present brooding equipment and using plenty of range and additional range shelters. The surplus pullets can be sold if it is not practicable to provide the additional suitable laying facilities necessary to accommodate them. Other poultrymen can expand their laying facilities first, by the adaptation of suitable barn or other farm building space available. Without any change in brooding or pullet growing facilities, they can safely coordinate their expansion by keeping over their select yearling hens another year or by brooding September-hatched pullets to succeed the hens in December, January, or February, depending upon when it may be necessary to transfer the September-hatched pullets to the laying quarters.

Any farmer who finds it practicable to expand his poultry enterprise in 1943 in keeping with good poultry husbandry (safe, coordinate expansion) would seem well advised to do so. Especially should he feel encouraged to expand if he can do so by more frequent use of his present brooding equipment, by greater use of pasturage and additional inexpensive range shelters not involving the use of wire or sheet metal, and by using increased laying facilities made available by the use of barn or other farm building space which can be made into suitable quarters for layers at a minimum of expense of labor and critical materials.

CHART SHOWING THE RANGE AND HOUSING REQUIREMENTS FOR CHICKS, GROWING PULLETS, AND LAYERS

Number of chicks to start for growth of pullets, broilers, or roasters in each 10 by 12-foot colony brooder house and each 10 by 12-foot range shelter under different management procedures. In a smaller colony house and range shelter, the number of chicks will need to be reduced accordingly.

Management of chicks and growing pullets	Number and kind of chicks			
	Leghorns		Heavier breeds	
	Unsexed	Sexed	Unsexed	Sexed
Chicks and growing pullets confined to colony house or to sun porch until ready to lay	150 to 200*	100 to 125	125 to 150‡	75 to 100
Chicks confined to colony brooder house or to sun porch during first 7 to 10 weeks with free range afterwards:				
Colony house only	250 to 300*	125 to 150	150 to 200‡	100 to 125
Colony house and range shelter	250 to 300†	150 to 200†	150 to 200§	125 to 150†
Chicks brooded in colony house on range; chicks on free range after first 2 to 3 weeks:				
Colony house only	250 to 300*	125 to 150	150 to 200‡	100 to 125
Colony house and range shelter	300 to 350†	200 to 250†	200 to 250§	200 to 225†

*Cockerels to be removed at the end of 4 weeks.
†Half the pullets to be transferred to a 10 by 12-foot range shelter when 7 to 10 weeks of age.
‡Cockerels to be removed as soon as they can be distinguished.
§Cockerels to be removed to range shelter as soon as possible.

Range Requirements for Growing Pullets

No definite figures can be set up for the range area necessary for growing pullets, since the amount of pasturage will be determined by the soil, climate, rainfall, and kind of pasturage. In most instances, however, each acre of good pasturage will serve 200 to 300 pullets.

Housing Requirements for Layers

Leghorns—3 to 3.5 square feet of floor space per bird, including droppings pits
Heavier breeds—4 to 4.5 square feet of floor space per bird, including droppings pits

FEEDING AND MANAGEMENT OF GROWING CHICKENS

D. C. KENNARD AND V. D. CHAMBERLIN

Because of the wartime demand for broilers and roasters for meat, as well as the need for increased egg production, the number of chickens to be raised in 1943 promises to break all records. In this major undertaking, the cost of feed will exceed all other costs combined. What is more, certain feed products needed for best results may be unavailable at times. In this emergency, what can poultry raisers do to protect themselves against losses they may experience under such circumstances? Resourceful poultrymen will generally find their way through such difficulties, at least with partial solutions of their problems.

In the first place, the feeding program should involve a minimum use of scarce feeds, such as meat, fish, milk, and alfalfa products. Such a feeding program will necessitate growing the chickens on green pasturage, where only a simple, comparatively inexpensive ration will be needed to supplement the green feed. This simple ration and the method of feeding growing chickens for meat and eggs were described in the Station's Bimonthly Bulletin for March-April, 1942, and in Poultry Pointers, No. 68, September 1942, "1943 Ohio Poultry Ration", Agricultural Extension Service, The Ohio State University. Although the formula for this range ration calls for 10 per cent of meat scraps, the meat scraps can be partially replaced by tankage, soybean oil meal, corn gluten meal, or cottonseed meal, if only a limited amount of the meat scraps is available. If meat scraps are unobtainable, it will be necessary to substitute them altogether with some other source of protein, such as tankage, soybean oil meal, corn gluten meal, cottonseed meal, or a high-protein mash supplement.

The range ration involves the use of a large proportion of whole and ground corn. In an experiment on the feeding of 5,000 chicks and 2,000 pullets and roasters at the Station's Poultry Plant in 1941, the birds consumed 66.2 per cent of whole and ground corn, 8.6 per cent of whole oats, and 17.1 per cent of the mash ingredients (bran, meat scraps, soybean oil meal, oyster shells, granite grit, and salt), not including the ground corn. By the use of this ration and good pasturage in 1941, the Station avoided the use of 1,380 pounds of milk products, 1,380 pounds of alfalfa meal, and 5,520 pounds of wheat middlings. Since vitamin D feeding oil is unnecessary for chickens on range, the range ration also avoided the use of 58 pounds, or $29 worth (at 50 cents a pound) of fortified 400 D feeding oil. Obviously, the growth of pullets, broilers, and roasters on good pasturage supplemented by a simple ration offers promising opportunities for farm poultry raisers in 1943. Besides the economy of growing chickens on a good range, raising on range is the surest way to produce pullets that will live and lay as they should.

Although the farm poultry raiser with plenty of good pasturage available has a decided advantage over those less fortunate raisers who do not have pasturage (the backyarders and suburban poultry raisers), there

are some helpful feeding suggestions for these people, too. In the Station's Bimonthly Bulletin for January-February, 1943, were reported experimental results with five different rations for the growth of chickens confined indoors. Among these rations was one without a milk product, which proved satisfactory. This ration involved the use of meat scraps, which have since become difficult to secure in some places. A second experiment with four rations has just been completed in which all animal feed products were eliminated from one of the rations.

PLAN OF EXPERIMENT

The second experiment was conducted with seven groups of White Leghorn pullets. Rations 1, 2, and 3 were fed to duplicate groups of pullets; only one group received ration 4. All groups received the same 18 per cent protein, all-mash chick starter during the first 7 weeks. During the fifth and sixth weeks, whole corn and oats were scattered over the top of the mash in the morning in about the amount that would be consumed during the day, to allow the chicks 2 weeks to become accustomed to the whole grain before the beginning of the experiment, in which all groups were given the free choice of whole grain and mash. The results of the second experiment with the growth of Leghorn pullets follow:

TABLE 1.—Composition of rations*

Ingredients	Ration numbers 1	2	3	4
Whole grain:				
Corn	F. C.‡	F. C.‡	F. C.‡	F. C.‡
Wheat	....	....	F. C.‡	....
Oats	20§	....	20§	20§
Mash:				
Corn, coarsely ground	32.0	37.0	32.0	29.0
Wheat, coarsely ground	....	....	....	25.0
Wheat middlings	15.0	15.0	15.0	....
Wheat bran	10.0	10.0	10.0	....
Meat scraps, 50 per cent protein	3.0	....	3.0	4.0
Dried whey	2.5	....	2.5	2.5
Soybean oil meal	10.0	25.0	10.0	12.0
Alfalfa leaf meal (dehydrated)	5.0	8.0	5.0	5.0
Salt	.5	1.0	.5	.5
Oyster shells, chick-size	2.0	2.0	2.0	2.0
Granite grit, chick-size	2.0	2.0	2.0	2.0
Bone meal	2.0	2.0	2.0	2.0
Vitamin A and D feeding oil (400 AOAC units of D per gram)	.4	.4	.4	.4
Percentage protein of mash or whole oats—mash mixture†	16.2	19.2	16.2	16.2

*Percentage of ingredients, not including grit and feeding oil.
†Calculated.
‡Free choice.
§Whole oats (20 per cent) – mash (80 per cent) mixture.

TABLE 2.—Weight and feed consumption of Leghorn pullets 8 to 16 weeks

November 12, 1942, to January 12, 1943—9 weeks

Legends	Ration number 1	2	3	4
Number of pullets	203	202	204	93
Percentage mortality	4	4	4	6
Initial weight at 7 weeks, lb.	.89	.92	.94	.93
Final weight at 16 weeks, lb.	2.21	2.37	2.33	2.43
Percentage intake of:				
Whole corn*	40.2	57.8	15.3	35.0
Whole oats†	11.9	....	10.5	13.0
Whole wheat*	....	....	32.3	....
Total whole grain	52.1	57.8	58.1	48.0
Mash† (without oats)	47.9	42.2	41.9	52.0
Total feed per pullet, pounds, 8 to 16 weeks	8.7	8.4	8.6	8.8

*Free choice.
†Fed as whole oats (20 per cent) – mash (80 per cent) mixture.

It will be observed in table 1 that the mash in ration 2 contained 3 per cent more protein than did the whole oats-mash mixtures in rations 1, 3, and 4. Nevertheless, the protein intake on the basis of total feed intake was precisely the same for all four rations. Obviously, growing pullets, like layers, can be depended upon to balance their rations properly when they are given the free choice of whole grain (even whole wheat) and a mash of considerable range in protein content.

In view of the wartime scarcity of animal feed products and the increased production of soybean oil meal (soybean oil meal has also been difficult to obtain in some instances), it is encouraging that the soybean oil meal ration with no animal feed products yielded the second best rate of growth of Leghorn pullets from 8 to 16 weeks inclusive. Although these pullets received no oats, no trouble was experienced from feather picking and cannibalism. Nevertheless, it is believed that whole oats would improve this ration, and certainly whole oats should be included as a preventive or control of feather picking and cannibalism when needed.

Again, as in a previous experiment, the rations (3 and 4) containing a liberal amount of either whole or coarsely ground wheat were among the best for growth of pullets or broilers. Again, the birds did not overeat of the whole wheat, as popularly supposed, when it was kept before them at all times, although they did eat twice as much of the whole wheat as of the whole corn (ration 3). As in the previous experiment, ration 4, in which the wheat bran and middlings were replaced with coarsely ground wheat (merely cracked), yielded the best rate of growth.

As in the previous experiment, the percentage intake of the mash with coarsely ground wheat was greater than that of similar mashes in which bran and middlings were used. This result suggests that coarsely ground wheat (merely cracked) makes the mash more palatable than bran and middlings. More than likely, the greater palatability and the resulting increased consumption of the mash containing the coarsely ground wheat were responsible for the increased rate of growth on it. Certainly, both experiments clearly indicate the advisability of using this type of ration for growing chickens whenever

coarsely ground wheat is available at the same or less cost than bran and middlings.

The primary problem of feeding poultry in 1943 will not be what is new and best in poultry feeding, but how best to make out with what is available. In many instances, poultry raisers will be obliged to use rations not in keeping with their past considerations. In other instances, owing to the inability to secure certain feed products or a favorite brand of feed, it will be necessary to take whatever is available. This emergency may involve radical and sudden departures from the customary types of rations and methods of feeding. It was with this in mind that the two experiments were conducted with rations for growing chickens. A ration without the use of animal feed products has been suggested. The greater use of whole and coarsely ground wheat has also been suggested. Of greater importance to the majority of farm poultry raisers in the solution of their poultry feeding problems will be the greater use of pasturage and a simple ration to supplement the green feed.

WARTIME MOTOR TRUCK TRANSPORTATION OF FRESH FRUITS AND VEGETABLES

CHAS. W. HAUCK

Maintenance of essential transport is one of the most critical problems now confronting the fresh fruit and vegetable industry. In recent years the industry has come to rely very heavily upon the motor truck for assembling and distributing supplies of these highly perishable products. The truck has introduced new elements of speed and flexibility into the marketing structure, and shippers, wholesalers, and retailers have all made adjustments in their operations coincidental with the development of truck movement. Diversion of automotive equipment to war purposes and resultant shortages of trucks, tires, and motor fuel have necessitated drastic curtailment of trucking operations by civilians. Great reductions in travel have been made, both voluntarily and by compulsion through governmental regulations, and even further reductions seem to be unavoidable.

The wholesale and jobbing functions are necessary steps in the movement of farm products from the producer to the consumer. If this stage in the distributive process becomes clogged for any reason, consumers quickly run short of needed foods, and supplies back up unsold and unsalable in the hands of growers. Especially is this true of highly perishable products. A bottleneck at this point is fully as disastrous as any calamity that destroys substantial quantities of essential goods or the ability of customers to buy. Therefore, anything which contributes to the preservation of these essential functions is beneficial not only to the distributors themselves, but also to producers and consumers, though this is not to say that nonessential competitive services and wasteful duplications or inefficiencies should not be eliminated in times of great national emergency.

In view of these considerations, motor truck operations of the firms operating in and adjacent to the Northern Ohio Food Terminal, Cleveland, Ohio, were surveyed, in collaboration with the trade, during 4 weeks, October 12-November 7, 1942.

Receipts reported by the 63 participating agencies, converted from packages into pounds, aggregated almost 43,000 tons, of which 33,000 were original receipts and the balance duplications or transfers or secondhand transactions of one sort or another. That is to say, these firms handled about 11,000 tons of produce weekly.

TABLE 1.—Receipts of fresh fruits and vegetables reported by 63 wholesale agencies, Cleveland, Ohio, October 12-November 7, 1942

Source of receipts	Volume received in 4 weeks, tons: By 63 agencies	Volume received in 4 weeks, tons: Average per agency	Per cent of total
Rail shipments from points outside Cleveland	21,494	341	50.37
Truck shipments from points outside Cleveland	12,038	191	28.21
Local fruit auction	4,198	67	9.84
Local farmers' markets	1,800	28	4.22
Other local jobbing firms	3,143	50	7.36
Total	42,673	677	100.00

The general nature of automotive transport used by 56 of these firms that reported truck travel in this period was:

Number of trucks used per day by 56 firms reporting	120	
Number of short trips (30-mile or less round trip) made with these trucks	9,824	(93 per cent)
Number of long trips (over 30-mile round trip) made with these trucks	756	(7 per cent)
Number of miles traveled on long trips	97,469	(72 per cent)
Number of miles traveled on short trips	38,901	(28 per cent)
Number of miles traveled for the purpose of procuring supplies of produce	55,282	(40 per cent)
Number of miles traveled for the purpose of delivering produce to customers	81,088	(60 per cent)
Number of tons of produce hauled in the process of procurement of supplies	13,685	(64 per cent)
Number of tons of produce hauled in the process of delivery to customers	7,586	(36 per cent)
Average number of miles traveled per trip	13	
Average number of miles traveled per ton of produce hauled on these trips	6.4	
Average number of miles traveled per ton of all produce handled (or received)	3.2	

These firms varied widely in the number of miles of truck travel required for each ton of merchandise hauled. On the assumption that firms with about the same amount of truck travel in a given period are reasonably similar in type and volume of business, these 56 firms were grouped for purposes of comparison.

TABLE 2.—Miles traveled, tons hauled, and miles per ton reported by 56 firms, Cleveland, Ohio, (averaged by groups of firms in order of miles traveled), October 12-November 7, 1942

Miles traveled in 4 weeks	Number of firms	Average miles traveled per firm	Average tons hauled per firm	Average number of miles traveled per ton hauled
500 or less	23	193.3	282.5	0.7
501-1,000	13	726.8	301.3	2.4
1,001-2,500	7	1,680.6	568.5	3.0
2,501-5,000	7	3,773.3	418.6	9.0
Over 5,000	6	14,049.8	663.0	21.2
Total or average	56	2,435.2	380.6	6.4

Some rather sharp variations in miles per ton existed between firms within the same group, that is, similar in total mileages traveled in the same period. Among the 23 firms with not over 500 miles each, 16 averaged less than 1 mile of travel to haul 1 ton; 6 averaged 1 to 2 miles per ton; 1 averaged 11.5 miles per ton. Among the 13 firms with 501 to 1,000 miles each, one averaged only 0.8 mile per ton; 9 averaged 1.6 to 3.9 miles per ton; and 3 ranged from 5.2 to 7.5 miles per ton. Among the seven firms with 1,001 to 2,500 miles, the range in miles per ton was from 0.7 to 19.6. The seven firms with 2,501 to 5,000 miles varied from 3.7 to 23.9 miles per ton, and the six firms with total mileages exceeding 5,000 varied from 5.8 to 39.8 miles per ton.

In all groups, therefore, there appear to be opportunities for some firms to raise their standards of transport efficiency.

CROP RESIDUES AND MANURE

HAROLD W. BATCHELOR

During the early stages of decomposition of plant and animal residues in the soil, the soil microorganisms which bring about these decompositions require rather definite quantities of nitrogen to carry on their life processes. Residues can be grouped roughly into three classes on the basis of their nitrogen content or the amount of nitrogen they can make available to soil microorganisms.

Class I.—If the residues supply just sufficient nitrogen to meet the needs of the microorganisms, but no more, there will result neither an increase nor a decrease of nitrogen available to plants growing in the soil while decomposition is taking place. As a general working basis, there can be considered in this class residues which contain approximately 2 per cent total nitrogen—the sods of certain hay mixtures plowed down as green manure and good quality animal manure. Applications of nitrogenous fertilizers to such sods or manures plowed down for spring-seeded grains would be expected to give profitable returns.

Class II.—If the residues contain more than the minimum amount of nitrogen (2 per cent) required by the microorganisms, this excess nitrogen will become available for the growth of the higher plants. Sweet clover plowed down any time from early spring to the flower stage contains as much as 3 per cent nitrogen and would be in this class.

The effect on the following grain crop of sweet clover plowed down as a green manure is particularly evident in the eroded land experiment started at Wooster in 1936. From part of the experimental field the surface soil was removed to plow depth. Another part was retained as the normal virgin soil. The first 4-year rotation on plot 9 on both the eroded and normal soil was: corn, oats, alfalfa, wheat; that on plot 10 was sweet clover, oats, alfalfa, wheat. In 1938, the second year of the rotation, the oats on plot 9 followed corn, while the oats on plot 10 followed sweet clover. The yields on these plots are given in table 1.

TABLE 1.—Yields of oats following corn or sweet clover
(Erosion Experiment—Wooster)

	Eroded land Bushels	Normal land Bushels
Plot 9 (oats after corn)	7.2	50.3
Plot 10 (oats after sweet clover)	59.5	29.4
	Gain 52.3	Loss 20.9

On eroded soil, there was an increase of 52.3 bushels of oats due to the sweet clover. On normal soil, the loss of approximately 20 bushels was due to excessive available nitrogen. The excess nitrogen resulted in early lodging of the grain, which prevented its being properly headed out.

At Wooster, biennial white sweet clover plowed down for corn in the spring of its second year of growth and fertilized with 0-20-0 has given 10.5-bushel increases of corn and 1.4-bushel increases of oats following the corn. When the clover was supplemented with both superphosphate and potash, in the form of 214 pounds of 0-14-6, 14-bushel increases of corn were obtained, reflecting the effect of potash and equaling the increase obtained with 4 tons of manure. The oats following the corn on this plot received 357 pounds of 0-14-6 and gave increases of 4.7 bushels compared with the plot with no sweet clover. Alfalfa has given about the same results as sweet clover, but both red and mammoth clover, with lower nitrogen contents than sweet clover and alfalfa, have been definitely inferior to sweet clover and alfalfa when used as green manures. The lodging of grains following the plowing down of the clovers may be attributed at least in part to an excessive supply of available nitrogen, resulting from the decomposition of these residues. In this connection, experiments have shown increased yields and reduced lodging of grains following the plowing down of straw or stover or both with the clover sods. Apparently the presence of these low-nitrogen residues prevents the accumulation of excessive nitrates in the soil (one cause of lodging), and the resulting better distribution of the nitrogen supply during the growing season results in increased yields.

In practice, the excess nitrogen produced from an average growth of sweet clover can be balanced approximately by the following quantities of low-nitrogen residues:

1,500 pounds of corn stover	(equivalent to that produced by 32 bushels of corn)
1,210 pounds of wheat straw	(equivalent to that produced by 13 bushels of wheat)
1,340 pounds of oat straw	(equivalent to that produced by 31 bushels of oats)
1,340 pounds of soybean haulm	(equivalent to that produced by 13 bushels of soybeans)

These quantities of low-nitrogen residues would just prevent the accumulation of nitrates during the early stages of decomposition of the sweet clover if the residues were finely chopped and uniformly mixed throughout the plow layer. In practice, such conditions are never attained, nor would they be advisable. Actually, the residues are localized in the furrow, and, therefore, the area of nitrate deficiency is also localized. While one part of the plant's root system may be experiencing a nitrogen deficiency within this area, other parts of the system may be in areas where an adequate supply of available nitrogen exists. Consequently, field experiments have shown that considerably greater quantities of the low-nitrogen residues than suggested

can be applied. Not only can these larger quantities be applied safely; they have actually given considerable increases in crop yields. In table 2 are shown the increases in corn and in oats following the corn when a combination application of 1,625 pounds of oat straw and 3,535 pounds of corn stover were plowed down with the sweet clover for corn.

TABLE 2.—Increases in corn and oats following plowing down of oat straw and corn stover with sweet clover for corn

(Sweet Clover-Green Manure Experiment—Wooster)

(8-year average)

Increase in bushels			
Corn	23.4	Oats	4.

Class III.—If the residues contain less than the minimum amount of available nitrogen (2 per cent) required by the microorganisms, the available nitrogen in the soil itself will be used by the microorganisms, and accordingly, the crop growing on the soil at that particular time will be deprived of its nitrogen needs until other decompositions take place in the soil or unless sufficient available nitrogen is added in the form of nitrogenous fertilizers. In table 3 are given the pounds of actual nitrogen in the form of fertilizers required to bring the quantities of low-nitrogen residues (expressed as pounds of air-dry residues per acre from yields given in bushels of grain) to 2 per cent nitrogen. From these results the quantities of nitrogenous fertilizers required can be calculated.

TABLE 3.—Pounds of nitrogen required per acre to bring the nitrogen content of the residues to 2 per cent

Type of residue	Bushel yield of grain	Pounds of stover	Pounds of nitrogen to be applied with residue
Corn stover	50	2,300	26.6
	60	2,760	32.0
	70	3,220	37.3
	80	3,680	42.6
Wheat straw	20	1,880	26.1
	30	2,820	39.2
	40	3,760	52.2
Oat straw	45	1,930	26.2
	55	2,350	32.0
	65	2,780	37.8
Soybean haulm	20	2,000	20.0
	25	2,500	25.0
	30	3,000	30.0

ANIMAL MANURES

Fresh stall manure, and particularly yard manure produced about a straw stack in a feed lot, may have approximately the same percentage of nitrogen on the wet basis (0.5-0.6 per cent) as straw or stover on the dry basis.

The actual percentage of nitrogen in the crop or the manure is of less significance than the ratio of the

nitrogen to the carbon in it. When roughages with initial nitrogen-carbon ratios of 1-80 emerge as manure, the ratio has been narrowed to about 1-20, but the percentage of nitrogen in the manure remains about the same as that in the original roughage on account of the increase in moisture content of the manure. The important thing is that the nitrogen-carbon ratio has been narrowed from 1-80 in the roughage to about 1-20 in the manure.

If the bedding is cereal straw and has been used in large amounts, the nitrogen-carbon ratio may be wider than 1-20. Such manure should be applied a considerable time ahead of the crop, be applied on leguminous sods, or be balanced with supplemental applications of nitrogen fertilizer.

These factors require that the manures be considered on a different standard from that for crop residues.

At Wooster in a rotation of corn, wheat, and clover, stall manure and yard manure, each supplemented with 32 pounds of 20 per cent superphosphate and each applied at the rate of 8 tons per acre, have been compared. The stall manure fresh from the stable was applied to sod in December or January. The yard manure was exposed in a flat, compact pile in the open from December or January until April, when it was applied to sod to be plowed down for corn. The stall manure has given about 15 per cent more increase in crop yields than the yard manure. Were not some of the stall manure nutrients lost in the field by surface washing during the winter, appreciably higher increases might be expected.

In another rotation at Wooster, of corn, soybeans, wheat, and clover, shed manure ripened 6 months and then plowed down for wheat has been compared with fresh manure applied as a winter top-dressing for wheat. The difference in the nitrogen contents of the two manures and the yields of wheat following their application are shown in table 4.

TABLE 4.—Ripened shed manure versus fresh manure

	Per cent nitrogen in manure	Increase in wheat grain over check plot, bushels
Ripened shed manure plowed down for wheat	0.87	4.9
Fresh manure	.53	.7
Difference in favor of ripened shed manure	.34	4.[illegible]

SUMMARY

Supplemental applications of nitrogenous fertilizers to sods of hay mixtures plowed down for corn can be expected to give profitable returns.

On account of its high nitrogen content, sweet clover plowed down any time from early spring to flower stage may produce during its decomposition, supplies of nitrate that are either untimely or excessive for the needs of the grain crop that follows. Such green manure can be supplemented with residues of wide nitrogen-carbon ratios, such as straw, corn stover, or soybean haulm.

Strawy manure should be applied a considerable time ahead of the following grain crop, be applied on legume sods, or be balanced with supplemental applications of nitrogen fertilizer.

CULTURE STUDIES OF THE DRUG PLANT *ATROPA BELLADONNA*

E. N. STILLINGS AND ALEX LAURIE

As shortages of crude drugs resulting from lack of imports developed, the need for growing our own crops of drug plants became evident. Lack of definite information and dependence upon empirical practices in the culture of several of these important crops led to the establishment of a Federal cooperative project in January 1942 by the Department of Horticulture of the Ohio Agricultural Experiment Station and the Colleges of Pharmacy and Veterinary Medicine of The Ohio State University.[1] Object of the project was to determine the best and simplest methods of culture for needed drug plants so that crops could be handled satisfactorily by growers in the State of Ohio.

Initial studies included *Atropa belladonna* (deadly nightshade), *Digitalis purpurea*, *D. lanata*, *D. lutea*, *D. ambigua* (foxgloves), *Hyoscyamus niger*, *H. pictus*, *H. pallidus* (henbanes), *Datura stramonium* (jimsonweed), *Carum carvi* (caraway), *Coriandrum sativum* (coriander), *Althaea officinalis* (marshmallow root), *Plantago psyllium* (French psyllium), *P. ovata* (blond psyllium), *Pimpinella anisum* (anise), *Capsicum frutescens* (cayenne pepper), *Chrysanthemum cinerariaefolium* (pyrethrum flowers), *Chenopodium ambrosiodes* (pigweed), and numerous plants belonging to the Labiatae (mint) family. As the studies progressed, it became evident that some of these drug plants were more important than others. Accordingly, work was centered on a few, of which *A. belladonna* is the most important. This progress report deals with studies on *A. belladonna*.

Belladonna is a bushy perennial herb native to central and southern Europe and Asia Minor. It is a member of the Solanaceae family. Its dark green leaves are alternate, broadly ovate, and entire or nearly entire along the margins and have an acute apex and tapered base. The flowers are usually solitary, rarely in clusters of two or three, axillary, and dropping. The fruit is a black berry with a persistent calyx.

Parts used in drug production are the dried roots and the dried leaves and flowering tops. These contain the alkaloids hyoscyamine, atropine, apoatropine, belladonnine, and scopolamine, which are used as anodynes, antiasthmatics, and mydriatics and to prevent griping of irritant cathartics, to relax smooth muscles, and to decrease secretions.

EXPERIMENTAL STUDIES

SEED GERMINATION

Seed was sown March 6, 1942. It germinated in 13 to 17 days, and the seedlings were ready to be pricked off 25 to 30 days from time of sowing. The temperature was maintained at 60° F. All media were sterilized.

Five media were used: one-third silt loam, one-third sand, one-third German peat; one-half silt loam, one-half sand; one-half sand, one-half German peat; one-half sand, one-half

[1]A fellowship to aid in these investigations is being sponsored by the S. B. Penick Company of New York City.

silt loam, with a covering of sphagnum moss; and German peat. Each mixture was divided into three sections: one watered overhead, one subirrigated with one glass wick to a flat, and one subirrigated with two glass wicks to a flat.

Table 1 shows the percentage of germination. Although no significant differences were observed between the media or the treatments, germination was higher than former reports have signified.

TABLE 1.—Belladonna seed germination tests

Medium	Treatment	Percentage germination
Soil, sand, peat	Two wicks	47
	One wick	42
	Overhead	29
Soil, sand	Two wicks	41
	One wick	21
	Overhead	36
Sand, peat	Two wicks	43
	One wick	35
	Overhead	35
Soil, sand, sphagnum	Two wicks	45
	One wick	37
	Overhead	42
Peat	Two wicks	43
	One wick	35
	Overhead	45

Using seed collected at Columbus during the summer, germination tests were begun again in December 1942. The seeds used for these tests were carefully segregated as to time of collection, condition of fruit at collection, age of plants (seed from 1- and 2-year-old plants was used), method of drying, condition after drying, and size of seed.

From results of the early part of this second germination study, it was evident that some form of treatment was needed to increase germination. Accordingly, different lots of seed were subjected to varying treatments, consisting of: soaking in water for 7 and 10 days; soaking in commercial strength sulfuric acid for ½, 1, 2, 5, and 10 minutes; soaking in commercial strength hydrochloric acid for ½, 1, 2, 5, and 10 minutes; cooling for 3 and 4 weeks before planting; cooling for 2, 3, 4, and 5 weeks after planting; alternate heating for 1, 2, and 3 weeks and cooling for 1, 2, and 3 weeks after planting.

The media were all composed of one-third silt loam, one-third sand, and one-third German peat, and all were steam-sterilized to avoid damping-off.

Since most of these second-year tests are not yet complete, no definite statements can be made as to which lot of seed or what type of treatment proved best. Observations show, however, that seeds treated with hydrochloric and sulfuric acid germinated more quickly than did the untreated check lots. These treatments also increased germination.

If an acid treatment is to be used, commercial strength sulfuric acid for

100 seconds is recommended. Whatever treatment is used, the germination will be very uneven.

A satisfactory method of germination consists of soaking the seeds for 24 hours in water, spreading them on two or three thicknesses of burlap placed in the bottom of a flat, covering with paper, and storing at 90° F. for 1 week. Seeds planted at the end of that time will germinate in 7 to 14 days. Such a method requires constant attention during the time the temperature is 90° F., for the seeds must never become dry.

Figuring 40 per cent germination, it will take approximately 3 ounces of seed to an acre if the plants are spaced 2½ feet by 12 inches.

PRICKING OFF STUDY

As soon as the majority of the seedlings had produced a pair of true leaves, they were pricked off.

To determine the most satisfactory type of plant to set out in the field, some seedlings were spaced 2 inches by 2 inches in flats; some were pricked off into 2½-inch pots; and the remainder were pricked off into 2-inch wooden plant bands. Plants were set in the field 12 inches by 12 inches, the second week of May. The plant bands were removed. There was no observable difference in growth or significant difference in production in this first planting.

Plantings made in late May and early June showed the pot and plant band treatment to be more favorable. These methods made possible more rapid establishment of the plant, which resulted in better growth during the warm, dry weeks. Although use of plant bands may be more convenient where hand labor is used in planting, these bands are expensive and will greatly increase the cost per plant.

If the plants are hardened off in a cold frame for 4 or 5 days, they can be planted in the field the latter part of April or in early May, depending on the locality. Light frosts will not damage them. Early planting is essential for high production.

Plants should not be set deeper in the field than they were in the original flats or containers, or stem rot may develop.

SPACING TESTS

Some plants were spaced 12 inches by 12 inches; others, 2 feet by 2 feet. Table 2 shows the comparative production.

TABLE 2.—Belladonna production spacing test

Treatment	Grams per plant*	Pounds per acre*
Spaced 12 inches by 12 inches.	63.4	6,086
Spaced 2 feet by 2 feet	61.3	2,942

*Dried and ready for assays. Unless specified otherwise, production figures are based on leaves and small stems (10 mm. in diameter or less).

The amount of material produced per plant was nearly the same in both treatments. By having twice as many plants per acre, with the 12-inch by 12-inch spacing, production is doubled. Spacing 12 inches by 12 inches is practical only for small plantings and when hand labor is to be used for planting, cultivating, and dusting; it cannot be used when horse-drawn or power equipment is to be used. For large plantings, the spacing of the rows will be determined by the nature of the equipment

to be employed. Plants in the row can be as close as 12 inches; the distance between rows will depend on the tools used. A suggested spacing is 12 inches in the row and 30 inches between rows. Such a planting will require 17,000 plants per acre. In plantings which are to be taken care of by hand, spacing 12 inches by 12 inches and leaving every seventh row unplanted will provide aisles through which all parts of the planting are accessible for all operations. This spacing will require 37,180 plants per acre.

Fig. 1.—*A. belladonna* growing under aster cloth (35 per cent reduction in light)

Picture taken 5 weeks after planting, before first harvest

LIGHT

To determine the effect of light intensity upon the production of belladonna and the synthesis of the alkaloid within the plant, plants were grown under aster cloth (35 per cent reduction of intensity), in a lath house (50 per cent reduction and shifting shade), and outdoors without protection. Four harvests were made from plants in each of these locations.

Table 3 shows the production obtained and the assay of the material from these plots.

TABLE 3.—Production of belladonna under varying light conditions

Treatment	Grams per plant	Pounds per acre	Assays,* per cent alkaloids
Normal	63.4	6,086	0.33
Cloth house	57.1	5,481	.22
Lath house	26.5	2,544	.23

*All assays were run at the College of Pharmacy by W. R. Brewer, graduate student, under supervision of Dr. L. David Hiner.

That reduction in light intensity is detrimental to total dry weight and alkaloid synthesis is evident. The material from the cloth house was bulky when harvested, but since it was succulent, the total yield of dried material was reduced. Plants grown in the lath house became very succulent, and their stems were long, thin, and weak.

NUTRITION

Since little information is available on nutritional requirements of belladonna, eight different nutrition levels, with varying concentrations of nitrogen, phosphorus, and potassium, were established. Each variation was used in soil with a pH of 6.5-7.5 and 5.5-6.5. Two plots with soil varying in pH as mentioned were treated with a starter solution (1 WP),[2] 6 gallons per 100 square feet, 2 weeks after planting. The concentrations of available nutrients were: high nitrogen, 50-100 parts per million; low nitrogen, 10-50 parts per million; high potassium, 20-40 parts per million; low potassium, 5-20 parts per million; high phosphorus, 5-10 parts per million; low phosphorus, 1-3 parts per million.

The soils were tested every 10 days, and corrections made as necessary. Plots which contained low concentrations were carried at the middle or below the middle of the ranges indicated. Those which contained high concentrations were maintained in the lower half of the range, except for potassium. Because of the nature of the soil and frequent rains, it was practically impossible to maintain a high level of this element. To the high potassium plots, therefore, frequent applications were made; to the low potassium plots, few.

Yields obtained from these plots are given in table 4.

TABLE 4.—Belladonna production in soils with variations in available nitrogen, phosphorus, and potassium and soil pH

Nutrient concentration	Soil pH	Pounds per acre			
		First harvest	Second harvest	Third harvest	Total
Starter solution	6.5-7.5	1,037	1,545	1,440	4,022
Starter solution	5.5-6.5	1,094	1,594	1,469	4,157
High N P K	6.5-7.5	2,304	1,757	1,920	5,981
High N P K	5.5-6.5	1,574	2,141	1,997	5,712
Low N, high P K	6.5-7.5	1,344	1,565	2,294	5,203
Low N, high P K	5.5-6.5	1,747	1,488	1,565	4,800
Low N P, high K	6.5-7.5	874	1,632	1,027	3,532
Low N P, high K	5.5-6.5	1,210	1,872	960	4,041
High N, low P K	6.5-7.5	1,776	1,939	2,102	3,897
High N, low P K	5.5-6.5	2,400	1,718	2,592	6,700
Low N P K	6.5-7.5	1,305	1,430	576	3,312
Low N P K	5.5-6.5	1,305	1,430	518	3,254
High N K, low P	6.5-7.5	1,267	1,142	2,054	4,473
High N K, low P	5.5-6.5	988	1,517	2,160	4,665
Low N K, high P	6.5-7.5	1,440	873	605	2,918
Low N K, high P	5.5-6.5	1,315	1,373	1,718	4,406
High N P, low K	6.5-7.5	1,882	2,217	1,939	6,038
High N P, low K	5.5-6.5	1,747	1,690	1,929	5,366

By adding together all yields in the same column from plots which had high concentrations of available nitrogen and likewise adding all yields in the same column from plots which had low concentrations of available nitrogen, the treatments can be correlated. This correlation was done with all treatments and for each harvest. The figures are shown in table 5.

[2]For constituents of this solution see Kiplinger, D. C., and Alex Laurie. 1942. Growing ornamental greenhouse crops in gravel culture. Ohio Agr. Exp. Sta. Bull. 634.

TABLE 5.—Belladonna production

Correlation table for nutritional variations

Pounds dry weight

Harvest	High N	Low N	High P	Low P	High K	Low K	Soil pH 6.5-7.5	Soil pH 5.5-6.5
1........	13,938	10,540	13,353	11,125	11,308	11,865	13,229	13,380
2........	13,921	11,663	13,104	12,680	13,114	12,670	14,100	14,823
3........	16,683	9,253	13,967	11,979	13,977	11,969	13,957	14,898
Total ..	42,132	31,466	40,424	33,874	38,407	35,891	39,376	43,101

High concentrations of available nutrients increased the total yield in every case, and with the exception of the potassium treatment in the first harvest, this trend is shown in each individual harvest. A slightly higher yield was obtained from plots at the lower pH. The high nitrogen and high phosphorus yields are definitely significant and show the needs of addition of these two elements if optimum yields are to be obtained. The high potassium yield, though somewhat greater than the low potassium, is not significant and suggests that high concentrations of this element are not essential for good growth.

A correlation for the assay of the materials grown in the nutrition plots is shown in table 6. It was derived just as was the production correlation.

TABLE 6.—Belladonna assays

Correlation table for nutritional variations

Percentage of alkaloids

	High N	Low N	High P	Low P	High K	Low K	High pH	Low pH
Leaves......			0.31	0.39	0.35		0.36	0.42
Whole plant.			.29	.31	.30		.32	.37
Whole plant.			.29	.32	.29		.33	.37

Contrary to popular belief and early reports, the figures in table 6 indicate that fertilization does not increase the amount of alkaloid produced by a belladonna plant.

The marked increase of alkaloids in the plants from the low pH plots is interesting, in that all recommendations for growing belladonna specify the necessity of heavy applications of lime.

Leaf material from the first harvest assayed higher than did the other samples of leaves and flowering tops.

Nutrient study plots were established in the greenhouse the first week of June. These consisted of gravel culture plots, in which the plants were grown in an inert medium and the essential nutrition was supplied by regular pumpings of water containing the dissolved nutrient salts through this medium. By this procedure the concentrations of essential elements were more easily controlled than in soil culture. Variations of nitrogen, phosphorus, and potassium were again used, but this time there were three variations

of each element rather than two. The greenhouse used was difficult to ventilate properly and was very hot during the middle of the summer, and adequate means for maintaining a high humidity were lacking. As a result, the growth of plants was unsatisfactory.

With three variations of the elements it was necessary to compare plots treated with but two variations. All those containing low and medium concentrations and medium and high concentrations were figured together. In the correlation table (table 7) it will be noted that high concentrations of available nitrogen and available phosphorus increased the yield. Medium potassium yielded higher than both low potassium and high potassium. This result was not surprising, as the increase from high potassium in the outside plot was not significant.

TABLE 7.—Belladonna production

Correlation table for gravel culture nutrition study

Treatment	Grams per plant	Pounds per acre
Low N	27.4	2,630
Medium N	58.1	5,577
Low P	37.6	3,609
Medium P	47.9	4,598
Low K	38.0	3,648
Medium K	47.5	4,560
Medium N	57.9	5,558
High N	71.7	6,883
Medium P	71.7	6,883
High P	57.9	5,558
Medium K	64.5	6,192
High K	65.1	6,249

Low—¼ WP; medium—1 WP; high—2 WP.

From these nutrition tests it is evident that if the soil does not already test high in available elements, fertilization is necessary for high yields. The application of fertilizer will be partially governed by the quality of material to be produced, as shown by the assay correlation table. Since higher prices are not paid for superior quality (assaying extremely high), it should be the aim of every grower to produce as much material of standard quality as possible. This cannot be done without fertilizers. Before planting, 20 per cent superphosphate should be well worked into the soil at the rate of 400 pounds per acre.

Ten days to two weeks after setting out in the field, growth should have started, and a side dressing of a complete fertilizer (3-8-7 will prove satisfactory) at the rate of 500 pounds per acre should be made. A similar application should follow the first and second harvests.

It is very important that the soil be well drained. This point cannot be overemphasized.

GREENHOUSE VERSUS OUTDOOR CULTURE

Because of the possibility of curtailment of flower crops in some greenhouses, it was deemed worth while to learn whether belladonna

could be grown successfully in the greenhouse.

On May 15, belladonna was planted in a raised bench of soil in the greenhouse to be grown under conditions of high temperature and high humidity. The comparative yields are given in table 8.

TABLE 8.—Production of belladonna—greenhouse versus outdoors

Date of harvests	Pounds per acre	
	Greenhouse, spaced 12 inches by 12 inches	Outdoors, spaced 12 inches by 12 inches
June 15	904	
July 6		1,276
July 21	880	
August 5		1,565
August 18	528	
September 1		1,382
September 7	880	
October 12	872	1,862
Totals	4,064	6,085

Although the greenhouse plots produced one more harvest than the outdoor plot during the same period of time, the outdoor plots produced more material.

Fig. 2.—*A. belladonna* growing in greenhouse

Picture taken June 14, just before harvesting

The plants grown inside became dormant in November, and all visible growth ceased. They were almost at the harvesting stage at the time.

On the basis of what has been harvested, 29 pounds of dry material could be produced on a bench 100 feet by 42 inches, roughly 350 square feet of greenhouse space, in 1 year. At an approximate cost of 75 cents per square foot per year for bench space and labor, it is readily seen that belladonna cannot profitably be grown inside.

HARVESTING

Material was collected when the plants were in flower and before formation of the fruit. If fruit is allowed to form, it will increase the time necessary for drying. Likewise, if the plant becomes mature, the next crop will take longer to develop, as the lateral buds will not break as quickly as they should.

The first harvests were made by cutting the stems 8 to 10 inches above the soil level. It soon developed that more material could be cut without endangering the continued growth of the plant. Accordingly, the stems were cut to within 6 inches of the soil level. This practice proved most satisfactory. To

determine just how far down material could be taken, some stems were cut to within 2 inches of the soil level. There were numerous disadvantages to this method: It left no foliage on the plant and thus definitely retarded growth. It removed practically all lateral buds which normally produce the next crop. Unless the soil was dry for a long period of time after harvesting, the roots rotted. Cutting this low took stems too large to meet requirements, and these had to be sorted out.

Too early application of water following harvesting caused the loss of numerous plants through root rot in a plot in the greenhouse. It was necessary to "dry off" the plants thoroughly before forcing growth. This procedure was practiced outdoors wherever irrigation of any form was used.

DRYING

Drying of the harvested material was first done by stripping the leaves from the stems and placing the material on 3-foot-square cloth-bottomed trays which fitted into racks. The trays were 4 inches apart in the racks to allow sufficient ventilation for both sides of the material. These racks and trays were located in a dry, well-ventilated building. From this method developed a less laborious procedure. Nails were driven through the thin width of wooden strips (10 feet by 1 inch by 2 inches) in alternate directions at intervals of 4 inches. The stems then cut were stuck on these nails, and the racks hung up to dry. After the material had dried, the leaves were stripped and saved, and the stems were discarded. After some stem material had been assayed and found to contain the required amount of alkaloids, stripping of the leaves from the stems was discontinued.

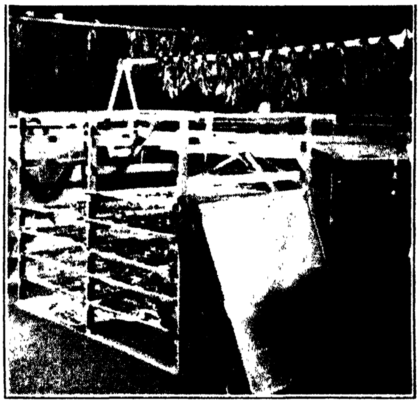

Fig. 3.—Belladonna drying on racks

(Trays contain other drugs.)

The length of time required for drying varied with each harvest, depending on weather conditions. Seldom was it more than 3 weeks.

To determine whether there was any movement of the alkaloids within the stems and leaves after the material was harvested, a large lot was divided into three samples: leaves and stems separated and dried on trays; leaves and stems separated after having been hung and dried on rack; material hung on rack and dried, left intact. Both material produced in the greenhouse and material produced outdoors were tested. Table 9 shows the assays of these materials.

When the material was hung up to dry, the leaves contained more alkaloids than the stems, whereas when the material was spread out on trays, the reverse was true. This result suggests translocation of the alkaloids after the material is harvested.

TABLE 9.—Belladonna assays—drying test

Treatment	Material	Greenhouse, per cent alkaloids	Outdoors, per cent alkaloids
Leaves and stems separated and dried on trays	Leaves	0.32	0.34
	Stems	.50	.53
Dried hanging, leaves and stems separated after drying	Leaves	.41	.38
	Stems	.45	.26
Dried on rack	Leaves and stems	.52	.36

INSECT CONTROL

Although no initial studies were set up to cover this phase of belladonna culture, much was learned regarding the damage done by insects, their occurrence, and their control. The first pest to appear was the greenhouse slug, which destroyed some seedlings before time for planting out. Damage could have been severe, but the insect was easily controlled by placing an arsenical bait in the vicinity of the seedlings. A leaf miner, believed to be the spinach leaf miner, appeared in plants in the greenhouse and caused severe damage. After transplanting, injury was less noticeable, and by the end of June there was no trouble from that source. Control of this insect in the greenhouse was best accomplished by spraying with nicotine sulfate 1-200.

Insects appearing on the plants outdoors were numerous. Colorado potato beetle, striped and spotted cucumber beetles, blister beetle, tortoise beetle, flea beetles, and leaf skeletonizers were the most serious pests. Since all these insects have chewing mouth parts, a stomach poison will control them. A dust composed of 85 parts sulfur and 15 parts arsenate of lead will prove satisfactory providing good coverage of foliage is secured. Applications of dusts will not impair the quality of the material produced.

Snout beetles appeared in early June and seemingly caused little injury at the time. Later, the larvae from the eggs laid by the snout beetles caused considerable damage by boring into the stems. This stalk borer can be controlled only by getting the adults. The sulfur-arsenate dust was as satisfactory as any remedy applied.

COST OF PRODUCTION

No accurate data are available as to the expense entailed in growing belladonna. It is estimated that it costs between $175 and $250 to produce an acre of belladonna. This cost will vary with methods of culture, pest control measures, and season.

CONCLUSIONS

Belladonna seeds germinate slowly and unevenly. By pretreating with sulfuric acid, soaking in water, and starting in high temperature and high moisture, 50 per cent germination can be secured.

No difference in yield was obtained from plants planted out of pots, bands, or flats.

Plants spaced 2 feet by 2 feet in the field yielded practically the same amount of material per plant as those spaced 12 inches by 12 inches.

Reduction of light intensity was detrimental to the total dry weight of material produced and to the synthesis of alkaloids within the plant.

High concentrations of available nitrogen, phosphorus, and potassium increased the yield of belladonna.

Slightly higher yields were obtained from plants grown in soil with a pH of 5.5-6.5 than from those grown in soil with a higher pH.

Fertilization did not increase the alkaloid yield.

Higher percentages of alkaloids were obtained from plants grown in soil with a pH of 5.5-6.5 than from plants grown in soil with a higher pH.

In samples from the nutritional plots (table 6), leaf material yielded a higher percentage of alkaloids than leaves and stems mixed. This is generally assumed to hold true, although the results shown in table 9 are somewhat contradictory.

Production from belladonna grown in the greenhouse was not as high as from that grown outdoors. Greenhouse production is definitely not profitable.

Stems could be cut to within 6 inches of the soil level without endangering the continued growth of the plant.

Translocation of alkaloids occurs after the material is cut.

Insects could be controlled by keeping the foliage covered with a stomach poison dust.

BELLADONNA CULTURE POINTS

Sow seeds February 15-March 1.
- Use sterilized medium.
- Three ounces of seeds are needed per acre if plants are spaced 12 inches by 2½ feet.

Prick off seedlings when first set of true leaves appears.
- Use sterilized soil.
- Space 2 inches by 2 inches in flat for most economy.

Plant in field May 1.
- Harden off in cold frame before planting.
- Don't plant too deeply.
- Spaced 12 inches by 2½ feet, 17,500 plants are needed per acre.
- Apply complete fertilizer, 500 pounds per acre, soon after planting and after each of the first two harvests.
- Dust frequently, keeping foliage covered.
- Cultivate as needed.

Harvest when plants are in flower, but before fruit sets.
- Normally there will be three harvests per year.

Dry in well-ventilated shed.

Possible production is 300 to 1,000 pounds per acre.

Estimated costs are $175 to $250 per acre.

TOMATO VARIETIES AND THE TIMING OF SPRAY SCHEDULES

J. D. WILSON

Most processors of tomatoes in Ohio depend on two or more varieties for their yearly pack. The use of early, medium, and late varieties helps to ensure an equalization of the daily volume of ripe fruit throughout the picking season. During the progress of various experiments on the control of leaf spot diseases of tomato in Ohio (1, 2, 3), it has been observed that all varieties do not respond alike to the use of fungicides applied on definitely timed spray schedules. Early varieties, such as Cobourg, were often severely attacked by early blight (*Alternaria solani* Jones and Grout) before the first application was made in a spray schedule timed to start July 10. Late varieties, such as Rutgers, were not protected late enough in the season by a schedule that ended August 10. Also, varieties with a determinate type of growth, like Huelsen, were usually less able to withstand a severe attack of leaf spot than others, such as Marglobe, which continued to produce new tip growth and blossoms until frost. In other words, the stage of physiological development or maturity of a particular variety, with respect to time, apparently determines to a large extent its response to disease attack, and, thus, to fungicides applied to control the disease.

In 1942 at Wooster, an experiment was begun in which the response of five tomato varieties with different maturity dates was observed when these were treated with a fixed copper (COC-S) spray formula on four differently timed schedules. The varieties used were Huelsen (very early and of determinate growth), Stokesdale (medium early), JTD and Baltimore (midseason), and Rutgers (late). The four spray schedules were of five applications at 12-day intervals. The earliest extended from June 20 to August 7, and the others were from July 2 to August 19, July 14 to August 31, and July 26 to September 12. Each schedule was applied to five 10-plant replicates of each variety, and an untreated check series included the same number of plants and replicates. In the text to follow, these schedules will be referred to according to their initial spray dates. Beginning on August 2, weekly estimates of foliage condition were made for each 10-plant replicate, and these data were averaged for each spray schedule and each variety. The ripe fruits were picked and graded at weekly intervals. The first picking for Huelsen and Stokesdale came on August 3, for Baltimore and JTD on August 10, and for Rutgers on August 18.

The fruit grades in this experiment were considerably affected by the weather, which was extremely dry during July and August, with only 1.35 inches of rain from July 11 to August 27, inclusive. Grade 1 corresponded to the U. S. No. 1 of the

1. Wilson, J. D. 1940. Spraying versus dusting of canning tomatoes with early and delayed applications. Ohio Agr. Exp. Sta. Bimo. Bull. 25: 76-84.
2. Wilson, J. D. 1941. Further studies on the use of fixed copper compounds for the control of vegetable diseases. Proc. Ohio Vegetable and Potato Growers' Assoc. 26: 20-33.
3. Wilson, J. D. 1942. The fixed coppers on vegetables in 1941 with special reference to the influence of supplemental materials. Proc. Ohio Vegetable and Potato Growers' Assoc. 27: 61-75.

canning trade. Grade 2 included U. S. No. 2 and a considerable number of very small fruits, caused by dry weather. The culls consisted almost entirely of fruits affected with blossom-end rot until and including the picking of August 31. During the first 2 weeks in September, many fruits were severely sunburned, and the last two pickings in September included many culls affected with Alternaria canker. At the end of the season, which came early because of a heavy frost on September 26, all green fruits were picked and weighed.

The infection index (4) of the different varieties was determined at 8 weekly intervals from August 2 to September 20 by assigning a value of 10 to plants with no defoliation and a value of 1 to a degree of defoliation that would represent the condition in which only a few small tufts of leaves are left on the ends of the branches, that degree of defoliation that often persists for several weeks without final death of the plants.

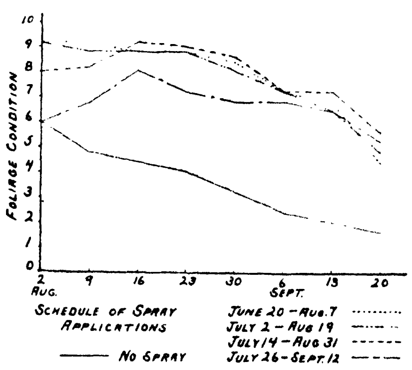

Fig. 1.—Influence of differently timed spray schedules on the progress of early blight on Huelsen tomatoes

Thus a reading of 7 indicated that 70 per cent of the leaves were still in good condition and that 30 per cent were dead or badly diseased. These index values were assembled and averaged in various ways to study the progress of disease development on each variety, for each spray schedule, and for various combinations of these. The progress of early blight, the only defoliation disease present in these plots, on the differently treated plots of the Huelsen variety is shown in figure 1.

Huelsen was the earliest variety used and, probably for this reason, the most severely diseased. In spite of the dry weather that persisted throughout August, early blight became progressively worse on the untreated check plots. At the time the first reading of disease incidence was made, August 2, the plots that had received their first spray on June 20, July 2, July 14, and July 26 had received four, three, two, and one, respectively. The disease became only slowly worse with the June 20 and July 2 schedules until after September 1. After this date, the protective effect of applications made for the last time on August 7 and 19 had apparently disappeared. A rain of 0.72 inch occurred on August 28 and washed off a great deal of the copper present until that time. The plots treated first on July 14 had developed some blight before the first application was made. This early infection was checked, and the foliage condition improved until August 16, after which it remained nearly stationary until after August 30. The last spray application on these plots was made August 31. The response of the July 26 series of plots to spraying was marked, with a

4. Horsfall, J. G., and J. W. Heuberger. 1942. Measuring magnitude of a defoliation disease of tomatoes. Phytopath. 32: 226-232.

rapid improvement from a foliage condition similar to that of the check to a score of 8 (80 per cent healthy) on August 16. The foliage condition on this plot had deteriorated slightly by August 23 but remained good from then until September 13, and 1 week later was actually better than that on the June 20 and July 2 series. The results obtained in these tests indicate that a spray schedule may be quite effective in disease control on an early variety if the first application is made shortly after early blight infection is visible and the spray is continued in several applications.

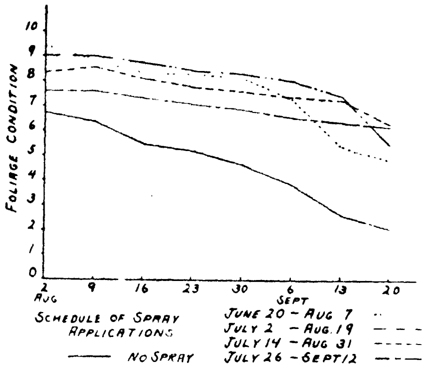

Fig. 2.—Average foliage condition of five tomato varieties under the influence of differently timed spray schedules

The average foliage condition of all five varieties for each spray schedule is shown in figure 2. The relative position of each of the schedules is similar to that for the Huelsen variety alone, except that the fluctuations from week to week are less, as would be expected. The June 20 schedule left the plants in the best condition on August 2. By August 9, the different schedules had assumed a foliage condition which they maintained until September 7. On this date, the plots treated first on June 20 showed more defoliation than those of the July 14 schedule. This accelerated disease incidence in the plants of the June 20 to August 7 schedule came about 20 to 25 days after the last application was made. This period was approximately the same for the July 2-August 19 and July 14-August 31 schedules. The almost unvarying foliage condition of the July 26-September 10 schedule indicates that midseason or late varieties should respond fairly well to treatments maintained between those dates. On the basis of these data, it would appear that the spray schedule should be so timed that the last application is made not more than 30 days before the average date when picking of a particular variety can be expected to cease.

The varietal response of tomato varieties to disease attack is indicated in figure 3. These data represent the progressive deterioration of the foliage under the attack of early blight on the untreated check plots of the Huelsen (early), Baltimore (midseason), and Rutgers (late) varieties. Tomato growers often express the opinion that Rutgers is more resistant to defoliation by leaf spot than most other varieties, but it seems more likely that it begins to lose leaves at a later date in the presence of these diseases because it is inherently later in reaching that stage of physiological maturity at which the plants begin to succumb to disease attack. Even in this experiment, where defoliation was not severe until comparatively late in the season, Rutgers had lost nearly as many of its leaves by September 20 as had Baltimore. The ability of Rutgers to go on developing new branches and new leaves on the ends of these branches as the older leaves are killed by disease, makes it appear to be more resistant to leaf spot than a variety of limited growth, like

Huelsen. Many fields of Rutgers had lost from 80 to 90 per cent of their leaves by September 20 in western Ohio in 1942.

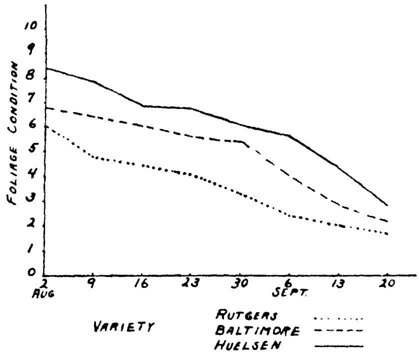

Fig. 3.—Varietal response of early (Huelsen), medium (Baltimore), and late (Rutgers) tomato varieties to disease attack when left unsprayed

The comparative percentages of different fruit grades from plots of Huelsen and Rutgers tomatoes sprayed on different schedules or left untreated are shown in figure 4. All plots of Rutgers produced a larger percentage of grade 1 fruits than Huelsen. Rutgers also produced a larger percentage of green fruits, as expected, since Rutgers normally matures much later than Huelsen. All treated plots of Rutgers had a smaller percentage of cull fruits than the Huelsen plots. Most of the cull fruits on the untreated plots of Rutgers were affected with blossom-end rot, which was very severe among the fruits of the first two pickings. The large quantity of grade 2 tomatoes on the untreated Huelsen plots was due to a lack of red color (and an excess of yellow) in the fruits on the severely defoliated plants. Sunburn was also common among the fruits of the last two or three pickings from the unsprayed Huelsen plants. Observations made during the progress of this experiment indicated that the Huelsen variety, with its determinate growth and limited leaf area, can be expected to give a better response to a spray program that will prevent defoliation than any of the other varieties used in this experiment or any variety not of determinate nature.

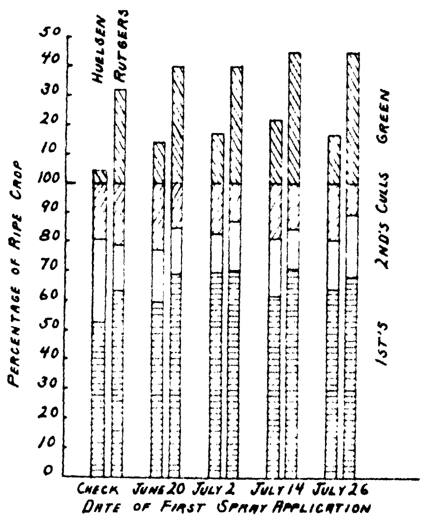

Fig. 4.—Comparative percentages of different fruit grades in Huelsen and Rutgers varieties treated on differently timed spray schedules or left untreated. Green fruits are indicated as percentage of total of ripened crop.

The average influence of spray timing on the fruit grades of all five varieties is shown in figure 5. Untreated plots produced the smallest percentage and the smallest amount of grade 1 fruits. The July 2 schedule gave a larger quantity but a slightly smaller percentage of grade 1 than either the July 14 or July 26 schedules. The June 20 schedule was lower than the others in both quantity and percentage, partly because of the large number of fruits affected

with blossom-end rot in the early pickings, and more culls than the other schedules in the last two or three pickings. The percentage of culls on the untreated plots was the largest of all and was almost 10 per cent above the average for the three latest schedules and 4.3 per cent above that of the July 20 schedule. The plants of the July 2 schedule bore both the largest percentage and the largest quantity of green fruits at the end of the season. Plants sprayed on June 20 produced the second largest amount of green fruit, and the untreated plants, the lowest quantity. The total yield of the plants in the July 2 schedule was about 15 per cent greater than that of the untreated checks and about 5 per cent above that of the second highest treated group (June 20). Thus, on the basis of average performance of the five varieties used in this experiment, the July 2 schedule was the best. Whether this would prove true in seasons of high summer rainfall remains to be determined.

The influence of spraying on the grade of different varieties is shown in figure 6. The percentage of grade 1 fruits for every variety was increased by spraying. The average increase over the checks was 10.4 per cent. The percentage of culls was reduced by spraying for all varieties but Huelsen, and for that variety, the values were practically equal on sprayed and unsprayed plots. The grade 2 fruits were nearly equal in the sprayed and unsprayed plots of each variety, with Huelsen again the exception. In that variety, the large number of off-color (yellow) fruits on the severely defoliated plants of the check plots increased the percentage of grade 2 fruits and correspondingly decreased the percentage in grade 1. The large quantity of grade 2 fruits in the Stokesdale and Baltimore varieties was largely due to dry weather, which caused many fruits to remain small. These small fruits were placed in grade 2 in this experiment even though they were otherwise good enough for firsts.

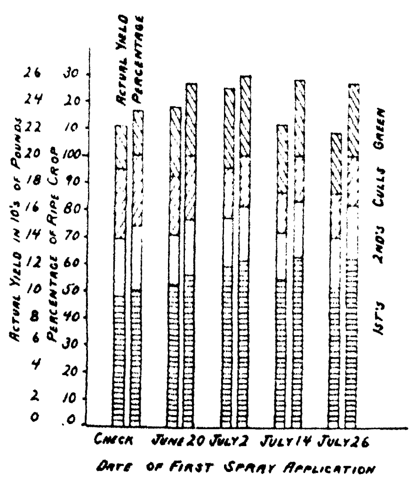

Fig. 5.—Average percentages of different fruit grades and actual yields for all five varieties when treated with differently timed spray schedules

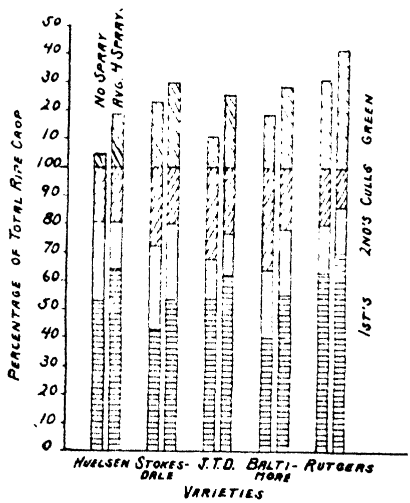

Fig. 6.—Comparative fruit grades in unsprayed and sprayed (average of all four schedules) plots for five different varieties

Rutgers and J. T. D. did not produce so many of these extremely small fruits.

The percentages of culls present in the fruits from the different spray schedules are worth noting in comparison with the variable foliage conditions. The average percentages for no-treatment plots and the June 20, July 2, 14, and 26 schedules were 23.8, 16.7, 13.1, 11.8, and 10.4, respectively. These results indicate that the later a plot was sprayed, the fewer the fruits that were diseased at the end of the season, as would be expected. Huelsen and J. T. D., the varieties with most complete defoliation at the end of the season, showed the largest average percentages of culls on all treatments. Baltimore and Stokesdale were intermediate in severity of defoliation and average percentages of culls. Rutgers, the latest maturing variety, showed the least defoliation near the end of the season, and the percentage of culls in the last two pickings was only about half so great as the percentages for J. T. D. and Huelsen.

The extreme defoliation of the untreated Huelsen plants is indicated by the very small quantity of green fruits left on the vines after the heavy frost of September 26. The quantity of green fruits left on the unsprayed check plots, as shown in figure 6, is fairly indicative of the foliage condition at the end of the season (see fig. 3). The Rutgers and Stokesdale checks were still in fair foliage condition until very near the end of the season. Although the inherent lateness or earliness of the varieties governs the quantity of green fruit left at the end of the season, Stokesdale, a comparatively early variety, had a considerable amount of unripened fruits left on the vines on September 26.

The influence of the timing of the spray schedule on the ripening curves of the different varieties was rather noticeable, just as it was on the foliage condition. The untreated plots of Huelsen, and of all the other varieties, for that matter, produced more fruits until the date of maximum production (August 31 for all but Rutgers; September 14 for Rutgers) than did the sprayed plots. For Huelsen, which was representative of the other varieties except Rutgers in this respect, the yields from plots sprayed first on July 26 followed the check yields closely until August 25, after which they began to fall behind and corresponded more closely to the production curve of the plots of the June 20 schedule. During the last 2 weeks of the season, the July 26 schedule was responsible for fewer ripe fruits than the June 20 schedule, but the quantity of green fruit at the end of the season was similar for the two schedules. In other words, from August 3 to August 24, the schedules ranked as follows: untreated, July 26, and June 20. On August 31 and September 7, all were nearly alike, and on September 14, 21, and 27, the two spray schedules were similar and the check plots dropped behind. This alteration in the ripening curve of untreated plants, in which the total production of these untreated plots remains greater than that from treated plants until midseason or later, has been noted before in this type of experiment (5, 6). For want of a better term, this condition is usually spoken of as the "delayed ripening" effect of spray materials that are capable of delaying the defoliation caused by disease attack.

The influence of the spray schedules used in this experiment on the amount of blossom-end rot that developed in the early part of the ripening season under the influence of extremely dry weather following plenty of rain in the early part of the

growing season, was marked on nearly all the varieties used. The percentage of end-rotted fruits that developed on the plants of the July 14 and July 26 schedules was less on every picking date than that on the untreated plots. In the July 2 schedule, the percentage of affected fruits exceeded that for the check plots on August 17 and 24 but was slightly less on August 10 and 31 and September 7. The June 20 schedule produced more fruits with blossom-end rot than the untreated plots on August 10, 17, and 24. The percentages on the two groups were approximately equal on August 31 and September 7. The average percentage of affected fruits for the three pickings falling between August 10 and August 24 was 35.9, 41.3, 36.1, 28.2, and 28.9 for the untreated plants and those treated on the schedules of June 20, July 2, July 14, and July 26, respectively. A larger percentage of end-rotted fruits on treated (especially with Bordeaux mixture) than untreated plants has been observed in several instances at Wooster (5, 6). This situation is likely to exist because treated plants bear a larger ratio of transpiring leaf area to each unit of fruit volume than untreated plants. Also, the sprayed leaves may lose water somewhat faster than those that are unsprayed. This sort of reasoning may explain the situation for the June 20 and July 2 schedules, but why there was less end-rot on the plants of the July 14 and 26 schedules than on the untreated plants, is more difficult to understand.

The J. T. D. variety proved to be most subject to end-rot (an average of 42 per cent of the fruits in the first three pickings). Stokesdale, Baltimore, and Rutgers were of similar susceptibility (35 per cent), and Huelsen was the least affected. The highest percentage of fruits affected in any one picking (70 per cent) occurred on Baltimore. The end-rot persisted in pickings from August 10 to September 7, with little or none in later harvests.

SUMMARY

Early maturing tomato varieties in Ohio are often not sufficiently well protected from disease attack at the beginning of the season by a spray schedule which begins July 10, and late varieties sometimes do not have protection when they need it late in the season from a schedule which ends August 10.

To study the relationship between spray schedule timing and the control of leaf spot defoliation on early and late tomatoes, five varieties with different maturity dates (Huelsen, early; Stokesdale, medium early; J. T. D. and Baltimore, medium; and Rutgers, late) were sprayed on four schedules of five applications each (12-day intervals) that had starting dates of June 20, July 2, July 14, and July 26.

The summer of 1942 was very dry during July and August, and, consequently, early blight (no septoria leaf spot was present) did not become severe at Wooster until much later in the season than usual.

The picking season was ended prematurely by a heavy frost on September 26, and this combination of dry weather and early frost undoubtedly had some influence on the type of results obtained in this experiment.

5. Wilson, J. D., and H. A. Runnels. 1937. Five years of tomato spraying. Ohio Agr. Exp. Sta. Bimo. Bull. 22: 13-18.

6. Wilson, J. D., and W. D. Moore. 1942. Comparison of sprayed tomato plants grown as seedlings in Georgia and Ohio. Ohio Agr. Exp. Sta. Bimo. Bull. 27: 17-25.

The infection index was obtained by scoring all plots (125) at weekly intervals from August 2 to September 20. Huelsen, the earliest variety, was most diseased throughout the season; Rutgers, the latest variety, possessed the best foliage record. The check (untreated) plots of all varieties deteriorated rapidly after August 30. The plots treated with the two earliest schedules, which received their last treatments on August 7 and August 19, began to show considerable defoliation after September 1. The plots receiving the latest schedule (starting July 26 and ending September 12), particularly those of the Huelsen variety, showed considerable defoliation before the first spray was applied, but their condition became static or improved slightly from that time onward, and the plots of that schedule were in the best condition of the whole group at the time they were frosted. The average plant condition for all five varieties throughout the season was best for the schedule which began July 2 and ended August 19. This schedule also produced the largest quantity of fruit and the best average grade.

Sprayed plots produced an average of 10 per cent more firsts than the untreated ones. The percentage of seconds was not materially influenced by spraying, except for the Huelsen variety, which produced a great many fruits in this class on the badly defoliated check plots.

Rutgers produced the highest percentage of grade 1 fruits and the lowest percentage of culls. Since Rutgers was the latest maturing variety used, it was not surprising that it also carried the largest quantity of green fruits at the end of the season. Huelsen and J. T. D., with the most defoliation, produced the largest percentage of culls and had the fewest green fruits left on the vines at the end of the season. Baltimore and Stokesdale were intermediate in defoliation and percentage of culls.

Spraying delayed the production of ripe fruits considerably, and the greatest delay was on the earliest schedule (June 20). The yield curve of the July 26 (latest) schedule followed that of the untreated plots rather closely during the first half of the picking season, but ripening slowed down to follow the yield of the June 20 schedule during the last half.

Blossom-end rot was more common in the fruits from the June 20 and July 2 schedules than in those from untreated plots, but this disease was least common in the fruits from the two latest schedules (July 14 and 26). J. T. D. was most subject to end rot, and Huelsen was least affected.

EFFECT OF TRANSPLANTING 4-YEAR-OLD APPLE TREES ON YIELD

C. W. ELLENWOOD

Frequently growers ask Experiment Station horticulturists whether it pays to transplant apple trees which have been growing in permanent positions in the orchard for a number of years. Results of transplanting such apple trees at the Experiment Station are presented here.

In the early spring of 1920, it became necessary to move a number of Stayman Winesap apple trees which had been set as year-old trees in one of the Station orchards in the spring of 1916. The method used was to dig a circular trench 3 feet or more in diameter around each tree and to lift the trees with as much soil as possible. Trees were moved on a sled a distance of 100 to 150 yards and planted in holes dug immediately preceding the transplanting. The tops of the transplanted trees were pruned back considerably after the trees were reset.

In an adjacent area, a number of year-old Stayman Winesap trees had been planted in a permanent position, also in 1916.

The yields from all these trees have been recorded throughout the life of the orchards and are summarized in table 1. The average annual yields of Stayman Winesap trees planted on a near-by tract of land in 1922 are also shown in this table.

TABLE 1.—Influence of transplanting Stayman Winesap on yield

Year planted	Treatment	Total yield per tree including crop of 1941	Total yield per tree, 4 years, 1938-1941
		Bushels	*Bushels*
1916	Transplanted in 1920	85.3	28.6
1916	Permanent	143.6	48.8
1922	Permanent	80.1	30.9

In addition to the total yield per tree to and including the crop of 1941, the yields per tree for the last 4 years of the period are presented in table 1. The transplanted trees are vigorous and healthy but are not so large as the trees which were planted in permanent positions in 1916.

It will be noted from table 1 that the trees originally planted in 1916 and then transplanted in 1920 have produced an average of 85.3 bushels per tree, whereas the trees planted at the same time and left in the original position have produced an average of 143.6 bushels per tree during the same period.

In a near-by orchard, Stayman Winesap trees planted in 1922 had produced an average of 80.1 bushels per tree by 1941, nearly as much as the transplanted trees. This comparison suggests that 1-year-old nursery trees set at the same time the Stayman Winesap trees were moved would have produced as much fruit

during the 22-year period as did the 4-year-old transplanted trees.

Moreover, a comparison of the yield of the three groups of trees during the 4-year period 1938-1941 shows that the transplanted trees actually produced slightly less fruit than those planted in 1922, and appreciably less than those which had been planted permanently in 1916.

It is realized that the data presented are confined to a single variety and are otherwise rather meager. However, it seems doubtful whether it is practical for the commercial grower to attempt to move normal-sized apple trees which have been planted in permanent positions for as long as 4 years. The cost of digging and again planting the trees with equipment commonly available to the average orchardist would exceed the purchase price and cost of planting 1-year-old nursery stock. Although the transplanted trees studied came into production somewhat earlier than 1-year-old nursery trees would have, this consideration was of minor importance from a commercial standpoint.

THINNING APPLE FRUITS AND CHANGING THE YEAR OF BEARING BY SPRAYING WITH DINITRO COMPOUNDS

FREEMAN S. HOWLETT

Fruitgrowers have recently become interested in the possible use of sprays to thin their apple crop and to change the year of alternation on alternate bearing trees. The problem of alternate bearing is a consequence of the pronounced tendency of apple trees in Ohio to produce in a cycle of heavy and light years and the low prices for the fruit in the heavy bearing year. In order to investigate the use of sprays for these purposes, the work reported was initiated several years ago, first with tar oil.

Although the original spray materials for this purpose were the tar oils, attention has shifted to the so-called dinitro compounds, possibly because the composition of tar oil distillates varies considerably, whereas the dinitro sprays involve one effective chemical, the concentration of which can be kept reasonably constant from year to year. This characteristic of dinitro sprays makes it possible to conduct over a period of years tests employing various concentrations, each of which can be repeated with the exact amount of the one effective chemical known, a situation not possible with the tar oil distillates.

All these tests have been largely exploratory, with the objectives of ascertaining whether the material would reduce fruit set without excessive injury to foliage and spurs and of ascertaining what concentration would produce the most favorable

effects in flower thinning and fruit removal. That injury to foliage, spurs, and secondary shoots would prohibit the use of these materials seems evident, in view of the importance of these portions of the tree in growth and fruit production.

Because of the interest of growers, results obtained during the past 3 years are reported. From this report the grower can make his own decision as to whether he wishes to employ these materials under his conditions in attempts to thin the crop or change the year of alternation.

Work at Wooster has been conducted primarily with trees bearing alternately heavy and light crops, or no crops in the "off" year. The purpose of using such trees has been to observe the effect of the treatment upon flower bud differentiation for the succeeding year's crop. Tests with annual bearing trees are satisfactory only in studying the effect of the material in thinning the current crop. Obviously, the effect upon changing the year of alternation cannot be obtained by using such trees.

Tests were made on 24 apple varieties during the period 1940 to 1942. Because trees of standard commercial varieties were not available for this test, the work reported was in part with some varieties which are of little or no commercial importance. However, the tests did include Cortland, Baldwin, Grimes Golden, Melba, Northern Spy, Oldenburg, and Wealthy. The trees were growing in the Station orchards either in mulch or sod with additional nitrogen. They ranged in age in 1940 from 14 to 48 years.

Before spraying, two carefully selected limbs on each tree were covered with large paper bags, 6 feet by 3 feet. The trees were thoroughly sprayed with a gun. A 300-gallon sprayer employing 500 pounds of pressure was used. As soon as the foliage had dried, the bags were removed from the limbs. Counts of the number of flower clusters were made on these unsprayed branches, as well as on two representative sprayed branches (usually forming a V-shaped pair with the unsprayed branch). The number of fruits set per cluster and the number of flowering clusters bearing fruits were counted both after the first and the second (June) drop. The sprays were applied, unless otherwise indicated, when the trees reached full bloom, that is, when 80 to 100 per cent of the flowers were in full bloom. Only limited attention was given to sprays applied during either the early or late cluster bud stage.

The dinitro compounds applied were contained in the following proprietary materials:

Elgetol, containing sodium dinitro-cresylate, 29.5 ounces of the effective chemical to 1 gallon

Dow Compound No. D-41 (DN Dry Mix, Wettable, No. 1)

Dinitro-ortho-cyclo-hexyl-phenol	40 per cent
Bentonite	40 per cent
Soybean flour	20 per cent

Dow Compound No. D-145 (DN Dry Mix, Wettable, No. 2)

Dinitro-ortho-cresol	40 per cent
Bentonite	60 per cent

The Dow materials were employed in an oil emulsion containing 2 gallons of Shell spray oil. Two ounces of blood albumin and 6 ounces of bentonite were used as emulsifying agents for 100 gallons of emulsion.

PRESENTATION OF THE DATA

RESULTS IN 1940

The spray was applied primarily to thin the crop on Joyce and Melba. Elgetol at a 0.3 per cent concentration had no appreciable effect upon fruit set.

RESULTS IN 1941

Anoka and Oldenburg were given the one spray, and Joyce H-154 and Melba H-150, the first spray, on April 29. The one spray of 0.8 per cent concentration was applied April 30. The one spray on Baldwin, Cortland, and York Imperial, the first spray on Cortland H-116 and Porter F-638, and the second on Joyce and Melba were applied May 3. The one spray on Elmer, Ralls, and Glenton and the second on Cortland and Porter were applied May 5.

As indicated in table 1, the concentrations of Elgetol employed in 1941 were increased to 0.6 and 0.8 per cent. Carbolic acid was added to certain tanks to discourage subsequent insect visits but was ineffective.

It was found that though a material may reduce the percentage of flowers setting fruit after the first drop, the difference between sprayed and unsprayed branches may be nearly obliterated by the greater second drop from the unsprayed branches. Examples of this condition are results from the varieties Anoka, Glenton, and Oldenburg receiving 0.6 per cent Elgetol. Anoka and Glenton had a full commercial crop at maturity, but Oldenburg had slightly less than a full crop.

Roughly, the fruiting of 25 to 30 per cent of the flowering points, or one fruit cluster in three to four flowering clusters, is the approximate equivalent of a full commercial crop requiring no hand thinning. This index was used in evaluating the results.

The 0.6 per cent Elgetol slightly reduced the yield of Baldwin and Oldenburg below a full crop and removed all fruits from the sprayed portions of Cortland and York Imperial. There was a heavy second (June) drop from the unsprayed portions, even though the leaves were not injured by spraying. Ralls was not affected to any significant extent by the treatment. Foliage which was exposed at the time of spraying was largely destroyed.

With 0.8 per cent Elgetol, Joyce was unaffected, but Melba was greatly thinned. The foliage injury to each was extensive, with no observable difference between the varieties.

Two sprays at 0.6 per cent produced different effects on the four varieties employed. The crop on Melba and Cortland was removed by the first spray; that of Joyce was unaffected. Joyce was considerably thinned by the second. Porter was thinned by both sprays.

It should be emphasized that the foliage open at the time of spraying was greatly injured. In a number of instances, some spurs, invariably the weaker ones, were also killed. The secondary shoot from the cluster base was also injured or killed in some cases, particularly with the two Elgetol sprays. However, all the trees made a remarkable recovery. The foliage on the more severely injured trees appeared somewhat sparse, however, during the remainder of the season.

Despite the foliage injury, there was sufficient flower bud differentiation that Cortland and Melba produced at least a moderate, and in some instances a full, crop in 1942. York Imperial and Porter did not produce a crop commensurate with the reduction in yield brought about by the spraying, probably because of the severe foliage injury.

TABLE 1.—Effect of Elgetol upon fruit set, 1941

Variety and tree No.	Per cent of flowers setting fruit — After second drop: Unsprayed	Per cent of flowers setting fruit — After second drop: Sprayed	Per cent of flowering clusters with fruit — After second drop: Unsprayed	Per cent of flowering clusters with fruit — After second drop: Sprayed	Yield of tree, bu.: 1939	Yield of tree, bu.: 1940	Yield of tree, bu.: 1941	Yield of tree, bu.: 1942
Elgetol, 0.6 per cent, applied once								
Anoka F-625......	48.5* 19.7*	25.0* 16.1*	88.9 48.0	55.0 47.0	5.0	3.0	7.0†	2.0
Baldwin A-128.....	5.3 6.3	5.2 3.3	25.0 25.0	19.6 14.0	33.6†	2.2	21.5	1.4
Cortland H-151 ...	.6 1.4	.0 .0	3.1 5.4	.0 .0	5.5†	.6	.0	4.0
Cortland A-173 ...	....	.0	....	.0	6.2	.3	.0	4.0
Elmer F-627......	38.6 34.6	32.2 12.4	72.8 68.5	75.5 28.6	22.0†	.0	9.0	.8
Glenton F-634.....	8.7 8.1	10.6 6.2	34.8 22.5	34.0 21.8	19.0†	4.0	....	.0
Oldenburg A-228..	6.7 8.8	3.8 5.9	32.9 38.0	17.8 22.9	6.0	2.5	5.0	1.8
Ralls A-239.......	10.3 8.3	4.2 6.9	39.7 24.6	17.3 24.5	25.0†	1.0	17.0	10.0
Ralls A-240........	15.7 14.9	8.6 14.9	59.8 45.8	40.7 62.0	22.0†	.5	14.5	7.5
York Imperial A-309.....	2.9 2.6	.0 .0	13.6 13.2	.0 .0	17.3	.3	.4	7.0
Elgetol, 0.8 per cent, applied once								
Joyce H-145........	7.0 15.7	9.6 9.0	31.9 59.8	22.8 33.8	5.2†	2.5	5.0†	4.3
Melba H-156.....	6.6 23.2	1.3 3.8	31.7 76.0	6.3 18.8	1.2	.1	1.0	8.0†
Elgetol, 0.6 per cent, applied twice								
Cortland H-116...	4.3 .6	.0(1) .0(2) .0(2)	20.0 3.1	.0 .0	5.0†	2.5	.2	3.5
Joyce H-154.......	1.8 5.3	8.9(1) 1.1(2) 2.7(2)	8.8 20.8	31.1(1) 5.5(2) 11.3(2)	3.4	2.4	3.0	4.5
Melba H-150.......	9.0 3.5 1.4	.0(1) .0(2) .0(2)	36.6 17.4 7.0	.0(1) .0(2) .0(2)	3.0	.1	.2	3.0
Porter F-638......	17.0 22.7	6.4(1) 2.8(2) .0(2)	47.9 63.6	26.8(1) 12.8(2) .0(2)	23.0†	1.0	3.0	4.3

*Four branches, two unsprayed and two sprayed.
†Equivalent to full commercial crop.

Table 2 presents data for Compound D-41 (Dow Compound No. 1) applied at the rate of one-half pound to 100 gallons of oil emulsion. The spray applied during the pink stage to the four varieties reduced the yield of Atlas and removed the fruits on Newtosh but had no effect upon Patricia and Walker Beauty.

TABLE 2.—Effect of dinitro sprays upon fruit set, 1941

Variety and tree No.	Per cent of flowers setting fruit, After second drop: Unsprayed	Per cent of flowers setting fruit, After second drop: Sprayed	Per cent of flowering clusters with fruit, After second drop: Unsprayed	Per cent of flowering clusters with fruit, After second drop: Sprayed	Yield per tree, bu.: 1939	1940	1941	19
DN Dry Mix (D-41), ½ lb. in 100 gal. of oil emulsion (2 per cent)								
Atlas H-121*	16.0† 8.4†	5.0† 3.1†	52.0 32.3	23.3 13.6	1.5	1.6	....	1.5
Baldwin A-117	5.3 5.1	.4 1.3	25.4 23.1	1.9 1.3	13.0	1.5	14.5	.5
Joyce H-146	29.6 18.6	.0 .4	74.1 53.6	.0 .2	5.0	1.2	1.0	8.0‡
Melba H-149	14.9 10.6	.0 1.3	47.7 45.5	.0 6.4	3.5	.0	1.0	3.1
Monmouth Beauty H-157	.0 .0	.0 .0	.0 .0	.0 .0	2.0	2.4	.0	3.6
Newtosh H-126*	6.2 11.0	.0 .0	27.6 41.4	.0 .0	3.2	8.0‡	3.0	4.4
Patricia H-143*	25.2 22.4	17.2 30.2	72.7 58.8	59.5 76.4	2.5	.0	8.2‡	.0
Walker Beauty F-639*	3.8 7.0	6.3 2.6	18.1 34.0	28.5 13.2	20.0‡	19.2‡	24.0	9.7
DN Dry Mix (D-41), ½ lb. to 100 gal. of water								
Baldwin A-126	16.1 4.8	15.0 10.4	71.7 22.1	71.2 49.3	19.2	.5	33.0‡	1.
Cortland H-117	.2 1.9	1.4 1.5	1.2 8.1	6.9 7.5	4.2	1.5	2.9	4.
Joyce H-147	17.9 9.1	13.2 16.8	65.8 34.0	52.3 58.7	5.0	5.2	9.5‡	2.
York Imperial A-111	11.7 8.5	8.4 6.2	54.5 41.9	40.3 31.1	28.0‡	10.0	25.0‡	13.

*Spray applied when flowers were in pink stage.
†Four branches, two unsprayed and two sprayed.
‡Equivalent to full commercial crop.

The spray to the flowers in bloom was applied May 1. The tree of Baldwin was not thoroughly sprayed at the top, and in consequence, a fair yield was obtained in that portion. However, the differences between the sprayed and unsprayed portions in the central periphery of the tree indicated great reduction from the spray. The fruits were practically removed from Joyce, Melba, and Monmouth Beauty. All the foliage exposed at

the time of spraying was killed, but recovery was remarkable, and there were sufficient flower buds differentiating for practically a full crop in 1942. On the other hand, the material applied in water to four varieties caused only a crinkling of the leaves, and no effect upon fruit set.

RESULTS IN 1942

The Elgetol spray was applied on April 29. The trees, except Newtosh, receiving Elgetol were in full bloom. However, only one or two flowers of a cluster were open on Niobe and Northern Spy, which received Compound D-145 (Dow Compound No. 2).

TABLE 3.—Effect of dinitro sprays upon fruit set, 1942

Variety and tree No.	Per cent of flowers setting fruit, After second drop: Unsprayed	Sprayed	Per cent of flowering clusters with fruit, After second drop: Unsprayed	Sprayed	Yield of tree, bu.: 1940	1941	1942
Elgetol, 0.4 per cent							
Grimes Golden H-50	1.6* 10.9*	0.0* .0*	8.0 43.1	0.0 .0	6.0	8.0†	1.0
Joyce H-145	17.8 16.9	6.4 1.5	55.3 62.5	32.4 6.1	2.5	5.0‡	4.3
Joyce H-153	3.7 8.4	1.2 2.0	15.8 33.8	6.4 10.0	.2	.0	.4
Melba H-155	7.1 10.9	2.5 1.9	34.1 44.9	12.7 9.3	9.3†	.0	6.7
Newtosh H-125	18.6 15.7	5.7 8.4	54.6 50.9	22.9 32.1	5.0	4.4	3.8
Newtosh H-126	10.3 5.5	2.8 1.2	43.1 27.6	13.5 6.2	8.0†	3.0‡	4.4†
Wealthy H-94	10.1 14.5	4.5 7.6	42.5 45.4	22.9 34.2	11.4†	1.0	7.3†
Wealthy H-95	9.2 13.0	8.4 6.0	35.0 42.5	33.9 25.2	13.6†	1.2	8.0†
DN Dry Mix D-145, ¼ lb. in 100 gal. of oil emulsion (2 per cent)							
Fall Jenetting A-331	3.5 1.3	.0 .0	17.1 9.4	.0 .0	19.0†	.0	.7
Loy A-151	9.6 7.4	5.3 4.4	39 6 29.8	24.4 19.5	40.0†	1.0	32.0
Niobe F-626	14.5 8.7	5.1 1.7	30.8 20.6	21.1 7.5	29.5†	5.4	22.8
Northern Spy A-146	5.6 1.5	1.5 2.6	27.7 7.6	7.6 13.0	31.0†	2.5	8.8
Yellow Transparent A-83	11.1 4.1	7.0 4.1	42.9 20.3	31.9 16.5	16.0†	2.0	12.3

*Four branches, two unsprayed and two sprayed.
†Equivalent to full commercial crop.
‡Sprayed also in 1941.

Elgetol at 0.4 per cent concentration removed the crop from Grimes Golden and thinned greatly that on Joyce, Melba, and Newtosh. The Wealthy trees were hand-thinned; 575 to 760 apples were removed from each.

Dow Compound No. 2, at the rate of one-quarter pound to 100 gallons of oil emulsion, removed the crop from Fall Jenetting. The spray greatly reduced the percentage of flowers setting fruit after the first drop on the other four varieties, but the greater second drop of the unsprayed branches greatly reduced the differences. The crop on the sprayed trees represented, in general, slightly less than a full commercial crop. Although the injury to the foliage was considerable, it was much less than occurred in 1941 with the stronger concentration of dinitro-ortho-cyclo-hexyl-phenol. Many of the stems of unopened flowers were injured, a condition which resulted in considerable reduction in fruit set in Niobe and Northern Spy.

DISCUSSION

The data presented indicate that the problem of obtaining sprays to thin the crop or remove it altogether is a complex one. In the first place, varieties differed greatly in their fruit set following application of a material at a given concentration. Secondly, they appeared to differ in the number of flower buds differentiating for the succeeding year's crop following the spray application. For example, a concentration of Elgetol which practically removed the flowers from Cortland and Melba was relatively ineffective on Oldenburg and Wealthy. Furthermore, although no gross visible difference existed between the spray injury on York Imperial and Cortland, the former failed to respond as well in flower buds for the succeeding crop. These data thus lend support to the conclusion that the concentration required to thin the crop or to remove all flowers and fruits must be worked out for each variety.

Environmental factors, such as air temperature and relative humidity during or after the application of the spray, probably influence the amount of injury to the flowers, foliage, and spurs. It is conceivable that greater injury to flowers may occur at the higher air temperatures. These and other factors, such as those which influence the vigor of the trees, may account for seasonal differences in flower removal. That seasonal differences will occur is indicated in part by the effect of the 0.4 per cent Elgetol spray in 1942 and the 0.6 (first spray) and 0.8 per cent sprays applied in 1941 to the same variety. In fact, on the varieties as a whole, the 0.4 per cent concentration in 1942 seemed more effective than the two higher concentrations applied in 1941. The seasonal factor (apart from the varietal factor) may be responsible in part for the differences between the work of MacDaniels and Hoffman (1) and Hoffman (2) and that presented here. Hoffman reported more thinning of the fruit of Wealthy with 0.4 per cent Elgetol than obtained at Wooster on the same variety. Furthermore, 0.3 per cent Elgetol seemed more effective under their conditions than higher concentrations applied in these tests, but the varieties were different. The work in Ohio indicates that concentrations of at least 0.4 per cent are

1. MacDaniels, L. H., and M. B. Hoffman. 1941. Apple blossom removal with caustic sprays. Proc. Amer. Soc. Hort. Sci. 38: 86-88.

2. Hoffman, M. B. 1942. Thinning Wealthy apples at blossom time with a caustic spray. Proc. Amer. Soc. Hort. Sci. 40: 95-98.

required. Further tests at Wooster will include applications of Elgetol at 0.4, 0.6, and 0.8 per cent concentrations to the same variety. The data indicate that severe leaf injury will occur, but this injury seems unavoidable when Elgetol is applied for flower and fruit removal.

Compound No. D-41 (Dow No. 1) and Compound No. D-145 (Dow No. 2) were also quite effective in reducing fruit set when applied in oil emulsions. The first compound at the rate of one-half pound to 100 gallons appeared to be more concentrated than necessary for the apple varieties tested. Further work with this chemical will involve tests of weaker concentrations than those reported in this paper. Dow DN No. 2 at the rate of one-quarter pound to 100 gallons resulted in some thinning but in general was not toxic enough. Further work employing this chemical will involve concentrations of about the same range as to be used with dinitro-ortho-cyclo-hexyl-phenol. Whether these chemicals applied for the purpose of removing flowers will have approximately the same effectiveness at equivalent concentrations is not known at present.

Obviously, application of these materials should be made as soon as the trees have reached full bloom. Yet, in these tests, much killing of opened and unopened flowers resulted from stem injury; injury to the style of open flowers was also a common result of the spray application. Despite the reduction in fruit set resulting from these effects, the ultimate drop was influenced by leaf injury, which appeared to limit the amount of food available for the developing fruits during the June drop period.

SPECIFIC DIRECTIONS FOR FRUITGROWERS

It should be kept in mind that the use of these spray materials for the purposes described in this paper is still in the experimental stage and is, therefore, not recommended. No one can predict with certainty the results to be obtained with any material upon either thinning the crop or changing the year of alternation. Differences will be found between varieties, orchards, local environmental conditions, and even thoroughness of application. Obviously, the trees must be drenched in order to cover the stems of all flowers.

That there will be severe injury to the foliage exposed at the time of spraying is evident. Only time and further experimentation will give information as to what will be the cumulative effects of this injury upon growth of the tree and succeeding crops. It is to be expected that removal of the current season's crop by application of the spray will in some instances result in flowers' not being formed for the succeeding year. In the tests reported in this paper, certain varieties gave a better crop than others. Only continued work will give information as to what can be expected with each variety.

For those who, despite all these considerations, wish to try some material in an experimental way to thin the crop, Elgetol at a concentration of 4 to 5 pints to 100 gallons of solution might be employed. It should be thoroughly applied to the trees as soon as they reach full bloom. Where it is desired to remove the crop, Dow Compound No. 2 applied at a slightly stronger concentration than that employed in this work

might be chosen. It is probable that when it is applied at the rate of one-half pound in 100 gallons of oil emulsion, the flowers will be removed. Further tests with these materials may result in changing concentrations, and other chemicals may be found to be an improvement over the dinitro compounds.

The value of employing these materials in experimental work is that they can be used in succeeding years at different concentrations if the results obtained one year indicate the desirability of changing the concentration. Certain varieties, such as Yellow Transparent, Baldwin, Oldenburg, and Wealthy, are resistant to these materials applied to thin the crop. On the other hand, Cortland and Melba are sensitive to the applications. Their use with the light-setting varieties, such as Stayman Winesap, Delicious, and Turley, does not seem at present to have any justification whatsoever.

Although these materials cause extensive injury to the opening leaves, the trees if vigorous may make a remarkable recovery. Some spurs will be killed, but usually they are the weaker ones. It is probable that some spur thinning may even be favorable. Fortunately, the fruits remaining to maturity on the varieties used in these tests were not russeted or otherwise disfigured. Whether the fruits of Golden Delicious would be russeted by the spray is not known at present.

As indicated, Shell spray oil was used in making the emulsions. Whether spray oils of different viscosity would have different effects when applied with the DN dry mix compounds is not known. Different effects are a possibility, since at the concentrations employed, these materials are effective only in oil emulsion. It is emphasized that bentonite and blood albumin were used in making up this emulsion.

ABNORMAL PREHARVEST DROP OF APPLES

C. W. ELLENWOOD

There was an abnormal preharvest drop in Ohio apple orchards in October 1942. This drop first occurred in southern Ohio in the early part of October. The condition progressed slowly northward. First observations of the drop at Wooster were made the afternoon of October 10. By the evening of October 11, most varieties which had not been picked in the Experiment Station orchards had dropped very badly.

All varieties dropped considerably. There was probably more variation between individual trees within a variety than between varieties. Serious drops took place from Stayman Winesap trees which had not been harvested; some trees had as many as 50 per cent windfalls on the ground by October 12, and the average for this variety was fully 25 per cent of the total crop. The Baldwin crop had been harvested in the Station orchard, but in commercial orchards in the vicinity of Wooster and farther north where Baldwin had not been harvested, the fruit dropped as badly as that of Stayman Winesap.

CAUSE

Observations at the Experiment Station and elsewhere in the State did not reveal the cause of the drop. When abnormal drops of this nature have occurred in the past, it has sometimes been suggested that low temperatures a short time previous to the drop have been at least a contributing cause. Other suggested possible causes have been heavy rainfall or high temperatures during the period just preceding normal harvest dates, and high winds, such as occurred September 25, 1941. Maximum and minimum temperatures at Wooster for the period September 25 to October 15, 1942, are shown in table 1; rainfall for the summer and fall months from May 1 to October 15 is recorded in table 2.

TABLE 1.—Temperatures

Date	Maximum	Minimum
September 25	60	33
26	76	40
27	52	32
28	53	27
29	59	27
30	68	32
October 1	76	37
2	79	47
3	79	52
4	70	56
5	61	50
6	64	34
7	74	44
8	79	39
9	77	54
10	71	46
11	67	39
12	67	40
13	65	46
14	56	52
15	63	56

Table 1 shows that during the period from September 27 to September 30, temperatures were rather low. Twice during this period, minimum temperatures of 27° F. were recorded. The fruit drop started about 10 days after that period.

TABLE 2.—Rainfall

Month	Monthly rainfall, 1942	Average monthly rainfall, 50 years	Deficiency of 1942 rainfall below 50-year average
	Inches	*Inches*	*Inches*
May	3.73	3.73	0.00
June	3.33	3.92	.59
July	2.12	4.06	1.94
August	1.32	3.63	2.31
September	2.77	3.26	.49
October 1-15	1.08	1.28	.20
Deficiency of rainfall for May 1 to October 15, 1942, from average for period			5.53

Table 2 shows that the rainfall for each monthly period except May was less than the average. Although data available do not establish the relatively dry growing season as the main reason for the drop, it may have been a contributing cause. The beginning of this drop in 1942 was not accompanied by rainfall.

PRESSURE TESTS

The standard mechanical pressure tester was used during the season to determine the firmness of flesh of the apples for storage studies. Some of these data are shown in table 3.

TABLE 3.—Pressure tests, 1942

Date	Variety	Pressure
		Pounds
September 21	Delicious	16.17
28	Delicious	15.62
October 2	Delicious	15.17
9	Delicious	14.02
5	Stayman Winesap	16.35
13	Stayman Winesap	15.88
8	Rome Beauty	17.68
13	Rome Beauty	17.55
15	Rome Beauty	16.72

Pressure data do not show any unusual drop in the pressure of Delicious, Stayman Winesap, or Rome Beauty during the period just preceding the 1942 drop. Pressure tests of this nature are useful in determining the proper condition of fruit for picking, but considered alone in 1942, they would not have given any indication of an approaching abnormal drop.

TIME FROM FULL BLOOM TO FIRST PICKING

Table 4 shows the number of days from date of full bloom of Delicious, Baldwin, Stayman Winesap, and Rome Beauty to date of first picking in 1942, also similar data for a 30-year period. It shows that the bloom period in 1942 was a week to 10 days earlier than the average, and, moreover, that the period from first to last bloom this year was much shorter than normal.

TABLE 4.—Number of days from full bloom to first picking

Variety	Date harvest was begun in 1942	Number of days from full bloom to first picking, 1942	Number of days from full bloom, October 10, 1942	30-year period, 1910-1939		
				Number of days from full bloom to first picking, average for 30 years	Fewest number of days from full bloom to first picking in any season during 30 years	Greatest number of days from full bloom to first picking in any season during 30 years
Delicious	Oct. 2	158	166	153	141	163
Baldwin	5	159	164	161	147	166
Stayman Winesap	12	165	163	168	162	183
Rome Beauty	15	168	162	167	155	178

It will be noted from table 4 that the harvesting of Delicious in 1942 was later than average. However, Delicious trees which were harvested before October 10 did not drop badly. Baldwin trees were harvested a little ahead of the average, and only on trees which were not picked before October 10 was there any serious loss.

Ordinarily, the use of the average number of days from bloom to harvest is a rather safe guide by which to set a picking date for winter apples. It can readily be seen, however, that during the 1942 season, use of such data would not have enabled growers to avoid heavy loss from windfalls. The total number of days from full bloom of both Stayman Winesap and Rome Beauty to October 10, the date the drop began, was 5 days less than the 30-year average from bloom to picking date.

The temperature and rainfall data in tables 1 and 2 may give some indication of the cause of the serious loss from windfalls in 1942, but further observations are needed to establish the definite cause or causes. It is highly desirable, if possible, to establish some practical way of anticipating such abnormal drops.

VARIATIONS IN THRIPS POPULATIONS ON ONIONS

J. P. SLEESMAN

INTRODUCTION

The onion thrips[1] is a minute insect which is generally distributed in all onion-growing sections of the United States. Both the adults and the immature forms rasp and puncture the leaf tissue with their stabber-like mouthparts and suck up the exuding sap. Whitish blotches appear on leaves where they have fed, and as the attack increases in severity, the tips of leaves become blasted and distorted. Finally, the entire plant may be killed, and an undersized bulb result.

The onion thrips feeds on a number of plants other than onion. It attacks many weeds, some field crops, and nearly all garden plants. It often does serious injury to cauliflower, cabbage, tobacco, beet, carrot, turnip, rutabaga, alfalfa, and sweet clover.

Adult onion thrips are slender, yellow, active insects about 1/25 inch long. The adult female has four narrow wings; the male is wingless. Small white eggs are thrust by the female into the tissues of the stems or leaves and hatch in 5 to 10 days. The young thrips, or nymph, is similar to the adult but is a paler yellow. It becomes full grown in 2 to 4 weeks, a part of which time is spent as a resting stage in a small cell in the soil. After emerging, the adult female returns to the plant and soon lays eggs for another generation. Each year there are five or six generations, which overlap, so that eggs, nymphs, and adults can be found together throughout the summer. Adults and nymphs overwinter on crop and other plant refuse in fields or along the margins. For this reason, all parts of fields and near-by ditch banks should be kept clean of weeds and other plant growth.

For almost a century, entomologists have attempted to control the onion thrips. In the beginning, their efforts were largely remedial, and concerned almost exclusively with developing a satisfactory method of chemical control. In investigations by the Ohio Agricultural Experiment Station during the period 1931 to 1940, a number of insecticides were applied to onions in test plots to determine their efficiency in the control of onion thrips. The data collected do not warrant recommending any of these materials in the commercial production of onions. Although several insecticides are toxic to the thrips, the population is difficult to reduce, and numerous applications of costly materials at close intervals are necessary. Three important sources of reinfestation are constantly at hand: Numerous thrips are always protected between the innermost leaves of the plant. The pupal stage is spent in the soil out of reach of insecticides. Other host plants are numerous.

Until the last decade, little attention was given to the preventive mode of control which has as its objective the development of onion varieties resistant or tolerant to onion thrips. The first step in such a control program was to determine

[1] *Thrips tabaci*, Lind.

whether any cultivated variety or any other sort of onion was inherently resistant to the thrips. If such resistance could be found, the problem would remain to combine it with ability to yield and with good keeping qualities. In the beginning, the experiments were confined exclusively to domestic varieties. However, there was the possibility of obtaining a high degree of resistance or complete immunity in an onion from a foreign source, and, therefore, available foreign strains have since been included in the experiments.

REVIEW OF LITERATURE

Sleesman (1, 2) found the fewest thrips on Riverside Sweet Spanish and White Persian. The commonly grown yellow, white, and red Southport Globes had large thrips populations.

MacLeod (3) in New York State reported Utah Valencia, Utah White Sweet Spanish, Valencia, Riverside Sweet Spanish, Extra Early Red Flat, Yellow Danvers Flat, and White Portugal as resistant varieties. At McGuffey, Ohio, the last three were among the most heavily populated.

Jones et al (4) studied a number of domestic varieties and foreign sorts. White Persian was the most resistant in these tests. Factors tending to restrict the thrips population on this variety were thought to be: shape of the leaves; angle of divergence of the innermost leaves; and distance apart of the leaf blades on the sheath column.

Maughan and MacLeod (5) reported Sweet Spanish infested with significantly fewer onion thrips than any other variety tested. Avoidance by thrips, angle of contact of plant leaves, stage of growth of plants, and recovery of plant tissues from injury were thought to have some bearing on resistance in this variety.

Beaumont et al. (6) reported that onions with an upright growth and an open chit possessed resistance to thrips.

MATERIALS AND METHODS

The present study on the resistance of onions to attack by thrips was begun in 1931. The plan was to grow as many varieties (sorts, strains) as possible under conditions of natural infestation.[2]

During 1931, 1932, and 1933, plots contained five 16-foot rows spaced 14 inches apart. In succeeding years, the size of plot was reduced to a single row 10 feet long. Exception to this procedure was necessary where the supply of seed was limited. Each variety was replicated five times in randomized blocks.

Thrips populations were determined at the peak of thrips development by counting the thrips on five plants selected at random from each plot. In 1931, 1932, and 1933, both adults and nymphs were counted, but in 1934 and thereafter, only the nymphs were considered. The nymphs usually complete their growth upon the plant where they

1. Sleesman, J. P. 1932. The onion thrips. Ohio Agr. Exp. Sta. Bull. 497: 76-77.
2. Sleesman, J. P. 1934. The onion thrips. Ohio Agr. Exp. Sta. Bull. 548: 41.
3. MacLeod, G. F. 1933. Some examples of varietal resistance of plants to insect attack. Jour. Ec. Ent. 26: 1: 62-64.
4. Jones, H. A., S. F. Bailey, and S. L. Emsweller. 1934. Thrips resistance in the onion. Hilgardia 8: 7: 215-232.
5. Maughan, F. B., and G. F. MacLeod. 1936. Further studies of onion varieties and onion thrips. Jour. Ec. Ent. 29: 2: 335-339.
6. Beaumont, A. B., M. E. Snell, W. L. Doran, and A. I. Bourne. 1935. Onions in the Connecticut Valley. Mass. Agr. Exp. Sta. Bull. 318.

[2]Seed stocks of domestic varieties were provided through the courtesy of the Ferry-Morse Seed Company. Throughout the investigation, the Division of Foreign Plant Introduction of the United States Department of Agriculture has cooperated in securing seed of various strains from foreign countries.

hatch, and since they do not fly, can readily be counted. Nymphal count was, therefore, considered the better index of the actual population on a given variety.

Maturity of the onion plant was determined by the number of days from planting until the tops fell over.

RESULTS

In 1931, eight varieties were planted at McGuffey, Ohio. The number of varieties was increased to 20 in 1934 and to 44 in 1937. Most of the commercial varieties grown in the United States were used. In addition, a number of foreign strains were tested in 1935 and 1937.

The actual thrips population per plant for each domestic variety in each of the years tested is given in table 1. An analysis of the data indicates that there are significant differences in thrips populations

TABLE 1.—Thrips population per plant for each variety in each of the years studied at McGuffey, Ohio

Variety	Year and number of thrips per plant*									
	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
Southport Yellow Globe	697	103	338	118	254	92	19	28	66	288
Southport White Globe	695	66	....	88	....	122	21	23	....	262
Riverside Sweet Spanish	33	10	8	6	....	18	9	1	10	162
Ebenezer	581	110	....	143	74	....	18	22	....	....
Early Yellow Globe	400	115	....	122	118	....	17	32	77	....
Southport Red Globe	558	88	....	99	....	....	25	23	....	....
Yellow Globe Danvers	375	....	....	126	....	....	16	17	....	....
California Early Red	226	....	....	22	....	....	9	9	39	....
Ohio Yellow Globe	....	86	....	44	....	....	23	37	....	....
White Portugal	....	62	....	123	....	....	16	27	....	....
Prizetaker	....	19	8	15	....	36	6	3	....	....
Extra Early Red Flat	....	86	....	....	....	....	....	....	....	....
Ailsa Craig	....	....	137	....	....	....	19	12	....	....
Early Grano	....	....	....	9	33	13	8	1	5	49
Australian Brown	....	....	....	92	....	172	17	16	....	233
Yellow Bermuda	....	....	....	10	....	20	10	6	18	....
White Persian	....	....	....	1	3	....	4	....	3	40
Yellow Strasburg	....	....	....	120	....	....	14	24	....	....
Mt. Danvers	....	....	....	85	....	....	15	26	....	....
Red Wethersfield	....	....	....	79	....	....	20	26	....	....
Crystal White Wax	....	....	....	16	....	....	7	6	....	....
Yellow Danvers Flat	....	....	....	87	....	....	....	....	....	....
California Early Yellow Globe	....	....	....	....	....	....	20	14	55	....
White Sweet Spanish	....	....	....	....	....	....	15	9	55	252
Sweet Spanish Valencia	....	....	....	....	....	....	5	2	9	....
Brigham Yellow Globe	....	....	....	....	....	....	16	33	....	....
Colorado Sweet Spanish	....	....	....	....	....	....	6	4	....	....
Denia	....	....	....	....	....	....	8	3	....	....
Espanola	....	....	....	....	....	....	5	12	....	....
Express Globe	....	....	....	....	....	....	7	5	....	....
Italian Yellow Globe	....	....	....	....	....	....	10	23	....	....
Mammoth Silver King	....	....	....	....	....	....	10	17	....	....
Red Bermuda	....	....	....	....	....	....	5	7	....	....
Riverwhite Globe	....	....	....	....	....	....	21	11	....	....
Barcelona	....	....	....	....	....	....	13	....	....	....
Barletta	....	....	....	....	....	....	15	....	....	....
Dark Red August	....	....	....	....	....	....	13	....	....	....
Earliest Paris Market	....	....	....	....	....	....	16	....	....	....
White Japanese	....	....	....	....	....	....	13	....	....	....
Yellow Japanese	....	....	....	....	....	....	17	....	....	....
Paris Silverskin	....	....	....	....	....	....	11	....	....	....
Oregon Danvers	....	....	....	....	....	....	16	....	....	....
Small White Nocera	....	....	....	....	....	....	13	....	....	....
California Early Yellow	....	....	....	....	....	....	12	....	....	....
Michigan Yellow Globe	....	....	....	....	....	....	17	....	....	....
Nebuka	....	....	....	....	....	....	14	....	....	....

*Figures are the means of five replications.

Difference between means required for significance: 1931, 183; 1932, 34; 1933, 52; 1934, 29; 1935, 57; 1936, 65; 1937, 8; 1938, 7; 1939, 27; 1940, 100.

among varieties.[3] The difference in population required for significance in making mean comparisons is given at the bottom of table 1.

The variety White Persian showed the lowest thrips population. Seed of this variety was obtained in Persia and was distributed as FPI 86279 by the Division of Foreign Plant Introduction. It was later named White Persian by the California Agricultural Experiment Station. A description and history of this variety appear in an earlier publication (4).

White Persian has several objectionable qualities as a commercial variety, chief of which are poor keeping quality and a tendency to grow "double" bulbs. The best use that can be made of this variety is to cross it with commercially important types in an attempt to incorporate into the commercial types those factors which restrict thrips population. Such investigations are being conducted by the United States Department of Agriculture in cooperation with the state experiment stations.

TABLE 2.—Relative mean thrips population per plant at McGuffey, Ohio

Variety	Population rating	Number of years tested
Southport Yellow Globe	100	10
Brigham Yellow Globe	100	2
Australian Brown	98	5
Southport Red Globe	95	5
Ohio Yellow Globe	94	5
Southport White Globe	93	7
Early Yellow Globe	91	7
Michigan Yellow Globe	89	1
Yellow Japanese	89	1
Red Wethersfield	88	3
White Portugal	86	4
Yellow Strasburg	86	3
Ebenezer	85	6
Earliest Paris Market	84	1
Oregon Danvers	84	1
Extra Early Red Flat	83	1
Mountain Danvers	81	3
California Early Yellow Globe	79	3
Yellow Globe Danvers	78	4
Barletta	78	1
Riverwhite Globe	75	2
Yellow Danvers Flat	73	1
Barcelona	73	1
Nebuka	73	1
White Sweet Spanish	70	4
Dark Red August	68	1
Italian Yellow Globe	68	2
White Japanese	68	1
Small White Nocera	68	1
California Early Yellow	63	1
Ailsa Craig	61	3
Paris Silverskin	57	1
Mammoth Silverking	56	2
California Early Red	38	5
Espanola	34	2
Yellow Bermuda	27	5
Express Globe	27	2
Denia	26	2
Red Bermuda	26	2
Crystal White Wax	23	3
Colorado Sweet Spanish	23	2
Prizetaker	18	6
Riverside Sweet Spanish	18	9
Sweet Spanish Valencia	15	3
Early Grano	14	7
White Persian	9	5

[3]Population is not correlated with maturity. In 1931, 1934, 1937, and 1938, r=0.08, —0.02, —0.15, —0.05, respectively.

Those varieties which are grown most extensively on a commercial scale, such as the yellow, white, and red Southport Globes, were found to be highly susceptible to attack by thrips. The less popular varieties of the Spanish type were intermediate in susceptibility. Inasmuch as the variety Southport Yellow Globe was included in each of the years the experiment was in progress, a population value of 100 was assigned to it. The population of every other variety was then determined in relation to this value. The means of the relative population values appear in decreasing order of magnitude in table 2.

Of the numerous introductions by the Division of Foreign Plant Introduction, none has had a thrips population lower than that of White Persian. In 1935, 21 strains were observed; all showed relatively high populations. Seventy-five foreign strains were studied in 1937; these showed a range in population from 8.6 to 30.0 thrips per plant, as compared with 6.9 for White Persian. In 1938, none of the 18 strains studied offered anything of importance from the standpoint of resistance.

SUMMARY

Progress has been made in experiments conducted for 10 years at McGuffey, Ohio, to test strains of onion for resistance to attack by onion thrips. Natural infestation was relied upon in the experiments.

Thrips populations were significantly larger on some varieties than on others. Varieties which are of greatest commercial importance in the United States were most susceptible. These are Southport Yellow Globe, Southport White Globe, Southport Red Globe, Early Yellow Globe, and Brigham Yellow Globe. Varieties of the Spanish type were intermediate in susceptibility. White Persian, an introduction from Persia, was the least susceptible to thrips attack. Although undesirable as a commercial variety, it is being used as a parent in a breeding program.

Immunity to thrips attack was not found in any of the domestic or foreign strains.

The possibility of obtaining a high degree of thrips resistance in commercial types through a breeding program appears promising. Such an effort is being made in cooperation with the United States Bureau of Plant Industry.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

From January 1941 to January 1943, farm wage rates in Ohio advanced by 68 per cent.

During the same period, the prices of farm products advanced by 60 per cent.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913...	102	...	101	101	104	100	105	101
1914....	99	...	100	101	102	102	105	109
1915..	102	...	105	98	103	107	106	112
1916....	125	...	124	118	113	113	121	123
1917....	172	...	149	175	140	119	182	201
1918...	192	...	176	202	175	131	203	243
1919..	202	...	202	213	204	135	218	270
1920..	225	...	201	211	236	159	212	230
1921..	142	...	152	125	164	134	132	134
1922..	141	...	149	132	145	124	127	133
1923...	147	...	152	142	160	122	134	147
1924..	143	...	152	143	165	118	133	150
1925..	151	...	156	156	165	110	159	180
1926 ..	146	...	155	145	170	105	155	183
1927..	139	...	153	139	173	99	147	171
1928.	141	...	155	149	169	96	154	163
1929...	139	...	154	146	169	94	151	172
1930..	126	...	146	126	154	90	128	142
1931...	107	84	126	87	120	82	89	105
1932...	95	58	108	65	92	70	63	77
1933...	96	61	108	70	74	59	69	87
1934....	110	77	122	90	77	63	85	102
1935 ..	117	87	125	108	87	66	110	132
1936...	118	102	124	114	100	71	118	152
1937 ..	126	120	131	121	118	75	128	164
1938...	115	87	123	95	117	74	103	140
1939...	113	103	121	93	117	76	95	140
1940...	114	117	122	98	116	77	99	146
1941...	127	170	131	122	138	80	121	185
1942..	...	...	...	...	...	...	157	244
1941								
January...	118	135	123	104	117	...	106	139
February	118	143	123	103	...	...	104	130
March...	119	149	123	103	...	80	106	138
April....	121	157	124	110	133	...	116	163
May....	124	165	125	112	...	...	121	173
June......	127	179	126	118	...	...	127	173
July.......	130	180	129	125	151	...	136	206
August	132	182	131	131	...	...	135	214
September	134	183	133	139	...	...	138	220
October...	135	187	136	139	155	...	133	219
November.	135	186	141	135	...	...	136	222
December.	137	193	143	143	...	...	140	226
1942								
January....	140	192	146	149	153	...	141	201
February..	141	199	147	145	...	...	144	183
March....	142	208	150	146	...	89	146	208
April......	144	210	151	150	167	...	153	230
May......	144	216	152	152	...	...	157	241
June.......	144	222	152	151	176	...	157	232
July.......	144	230	152	154	179	...	159	237
August ..	145	233	152	163	...	...	164	248
September.	145	237	153	163	...	...	161	268
October ..	145	249	154	169	193	...	165	290
November.	146	258	155	169	...	...	167	293
December.	147	266	155	178	...	...	169	297
1943								
January ...	...	...	...	...	196	...	...	...

*SOURCE: Bureau of Business Research, The Ohio State University.

ONTHLY BULLETIN

MAY-JUNE, 1943 NO. 222

OHIO AGRICULTURAL

YOUR AUTHORS

That there is a severe shortage of farm labor is now common knowledge. A great many people do not understand why, however, and many want to know what has happened to the young people who were living on farms at the beginning of the war. In his "Wartime Migration of Farm Youth", A. R. Mangus, Station rural sociologist, gives figures that help answer this question.

Mangus

To owners of badly eroded hill lands in eastern and southeastern Ohio, H. L. Borst, Project Supervisor of the Soil Conservation Experiment Station at Zanesville, and R. E. Yoder, chief of the Ohio Experiment Station's Agronomy Department, bring hopeful news. The "trash mulch" method of establishing alfalfa-grass meadows directly on these lands offers promise of restoring the productiveness. Their story tells the man who owns such land how to use it.

Borst

Yoder

To help farmers evaluate the performance of power buck rakes, C. B. Richey, Station agricultural engineer, reports tests on buck rake operation. In a second article, Mr. Richey offers farmers a new, simple method of determining the correct adjustment for combines, the one at which grain losses will be as small as possible.

Richey

As great numbers of new gardeners turn to the task of raising some of their own food for the first time, many questions come to J. H. Gourley, chief of the Station's Horticulture Department. Not the least often asked is, "What is the difference between a fruit and a vegetable?" If you think you know the answer, Dr. Gourley may have a surprise for you.

Gourley

J. T. McClure, Experiment Station weather observer, keeps a day-by-day record of temperature, rainfall, snow, and wind. His records in this issue may help settle some arguments.

McClure

Already old friends of Bimonthly readers are authors C. W. Ellenwood, fruit specialist; D. C. Kennard and V. D. Chamberlin, poultry specialists; J. D. Wilson, plant disease specialist; and J. I. Falconer, chief of the Station's Rural Economics Department.

IN THIS ISSUE

WARTIME MIGRATION OF FARM YOUTH

A. R. MANGUS

Since 1940, the requirements of the military services and of urban industries, together with the declining rate of population growth in the teen ages, have exerted their full impact on farm youth in Ohio, reducing their numbers in large proportions. Between April 1940 and January 1943, the double impact of the war and the population trend led to a decline of one-third in the numbers of young people 14-29 years old living on farms. During that period of 33 months of war and preparation for war, the farm youth population of Ohio decreased from 285,000 to only 191,000, a loss of 94,000 persons. Boys and girls of high school ages, 14-17 years old, declined about 10 per cent; youths 18-29 years old declined 44 per cent.

Most of the recent loss of farm youths of high school age can be attributed to declining numbers of births on farms 14 to 17 years ago. Depletion of the numbers of older youths on farms was, however, largely a result of an exodus from farms, an exodus which was stimulated by needs for war manpower in factories and in the armed forces.

These statements are based on information given by the Federal Census enumeration of the Ohio farm population in 1940 and on estimates provided by a field survey of farm youths in 44 sample neighborhoods scattered among 17 representative Ohio counties[1] in January 1943. Field work for the survey was conducted by members of the Older Rural Youth Executive Committee[2] of the Ohio Agricultural Extension Service. The data were recorded on a schedule carefully prepared by a member of the social research staff of the Ohio Agricultural Experiment Station. The 44 neighborhoods in the survey included 1,130 farm families with 805 youths 14-29 years old, a ratio of 71 youths per 100 families. This youth-family ratio was applied to all farm families in the State to obtain estimates of the total number of farm youths in 1943.

TABLE 1.—Estimated decline in the youth population on Ohio farms, 1940-1943

Age, years	Total number: Enumerated 1940	Total number: Estimated 1943	Per cent decline 1940-1943
14-29	285,000	191,000	33.0
14-17	92,000	83,000	9.8
18-19	43,000	31,000	27.9
20-24	84,000	49,000	41.7
25-29	66,000	28,000	57.6

[1]Counties included in survey: Belmont, Champaign, Columbiana, Darke, Hamilton, Hocking, Knox, Licking, Lorain, Montgomery, Noble, Pickaway, Shelby, Stark, Trumbull, Williams, Wyandot.

[2]The following persons participated in the survey: Elizabeth S. Carmichael, H W. Harshfield, C. C. Lang, A. R. Mangus, W. H. Palmer, Warren Schmidt.

The rate of decline in numbers of youths on farms during the past 3 years was proportional to their age. While children of high school age decreased only about one-tenth, youths in the older age groups declined at rates from about three to nearly six times as great.

Except for the age group 25-29 years, the rate of decline in farm youths was greater for boys than for girls. These differential rates of decline had by 1943 brought about approximate equality in numbers of male and female youths on farms. In 1940, there were 124 males for each 100 females 14-29 years old. According to present estimates, there were in January 1943, approximately 99 males per 100 females.

The neighborhoods included in the survey had lost a total of 203 of their farm youths 14-29 years old during the single year 1942, and that number constituted a departure rate of 20.8 per cent of the total youths resident on farms at the beginning of that year. The departure rates were highest for young men 18-29 years old and lowest for children of high school age.

About 90 per cent of the young men 18-29 years old who left farms in the survey areas during 1942 entered some branch of the armed forces. Others left to take nonfarm jobs, and a few moved to farms in other localities. It appears from this finding that the movement of civilian youths from farms to cities, towns, and villages was not a major factor in 1942. The peak of that movement probably came in the 2 previous years.

While comparatively few farm youths were moving to cities to take jobs in 1942, large proportions of those living on farms were employed at other than farm jobs. In the survey areas, 26.3 per cent of the male youths and 49.1 per cent of the female youths living on farms and out of school were working in nonfarm industries. Many were commuting considerable distances to work.

Although the number of resident farm youths 14-29 years old in Ohio has declined rapidly since 1940, there are still nearly 200,000 on farms. In January 1943, about 41 per cent were in school; 35 per cent were working on farms; and 21 per cent were

TABLE 2.—Rate of departure of farm youths from 44 neighborhoods during the year 1942

Sex and age in years	Population January 1, 1942	Departures during 1942	
		Total number	Per cent
Males, by age groups	558	171	30.6
14-17	171	7	4.1
18-19	86	17	19.8
20-24	191	101	52.9
25-29	110	46	41.8
Females, by age groups	419	32	7.6
14-17	169	2	1.2
18-19	75	13	17.3
20-24	118	11	9.3
25-29	57	6	10.5

employed at nonfarm jobs. The majority of male youths of military age and classified for the draft were in a deferred class or had been rejected, but 17 per cent of the total were in class 1A and awaiting induction.

The findings of this study are indicative of the severity of labor shortages faced by many farmers as a result of the loss of their children of working age to the armed forces and to urban industries. They indicate also the need for morale-building programs for those youths still on farms, for 37 per cent of the boys and 32 per cent of the girls were not participating in any organized group activities.

HOME POULTRY AND EGG PRODUCTION FOR WARTIME

D. C. KENNARD AND V. D. CHAMBERLIN

"Food for Victory" is beginning at home for many villagers and suburbanites. A family that can have a vegetable garden and chickens for meat and egg production is fortunate, indeed, during wartime food scarcities. For best results, the backyard vegetable garden and the chickens are inseparable; neither is complete without the other. Meat and eggs are needed to supplement vegetables for a balanced human diet; chickens need the by-product green feed from the vegetables to balance their diet; and the vegetables need the fertilizer from the chickens.

Fencing is necessary for best results with both the vegetable garden and the chickens. Chickens will need to be fenced in to keep them out of the garden, to protect them against dogs, and to keep peace on the home front. The fence will need to be 4 to 6 feet high, depending upon the kind of chickens and the size of the yard. Where the chickens are confined to a sun porch or to a small yard, it is often better to enclose the top, as well as the sides. If the top is enclosed, the sides need not be more than 2½ to 3 feet high. Since fencing is generally essential for the success of both the vegetable garden and the backyard poultry flock, it should be included among the first considerations in connection with these projects, owing to the limited amount of fencing available.

Backyard flocks were an important source of poultry and eggs prior to and during World War I, before the introduction of improved refrigeration and transportation facilities, and before the increased commercial production of poultry and eggs that followed. When these developments made good-quality poultry and eggs available at reasonable prices, the majority of the backyard flocks became obsolete. Village and suburban families now in the midst of World War II and the scarcity of meat and eggs, are again turning to the production of poultry and eggs at home. In this undertaking, there will be many beginners, as well as others with some previous experience who will feel like beginners when they start keeping chickens under present-day conditions and procedures. As with any new undertaking, beginners in home poultry and egg production will face many questions that will need careful consideration.

Of the many questions to arise, there are three of a general nature: What kind and how many chickens will best serve a family of three to five persons? What housing and equipment will be needed? What are some of the feeding and management considerations?

KIND AND NUMBER OF CHICKENS

The two principal kinds of chickens are Leghorns for egg production and the dual-purpose, heavier breeds, such as Plymouth Rocks and Rhode Island Reds, for meat and eggs. Inasmuch as the purpose of the home flock is to provide meat, as well as eggs, in most instances the heavier breeds are generally preferable. Nevertheless, many backyarders prefer their Leghorns.

Theoretically, a flock of 12 pullet layers should produce 4 to 8 eggs daily most of the time and provide sufficient eggs for a family of three to five. It must be remembered, however, that hens have their sit-down periods, vacations, and moulting periods, when they do not lay, and that not all the hens can be expected to live. Moreover, who would want a home flock without an occasional bird for the table? Consequently, 25 to 30 would be a better number with which to start. This size of flock will take little more attention than a smaller number. Moreover, whole grain and mash can be purchased and delivered by the hundred pounds to better advantage than in smaller amounts. Of still greater importance during wartime, is that the flock of 25 to 30 layers will generally provide eggs for sale to two or three neighboring families.

HOUSING AND EQUIPMENT

Another point also in favor of the 25- to 30-layer flock is that it can be accommodated in a 10- by 12-foot colony house, which is a desirable size of housing unit for the home flock. Generally speaking, a 10- by 12-foot portable colony house[1] will prove the most satisfactory for the home flock of 15 to 30 layers, or it can be used for brooding 100 to 200 chicks for the growth of pullets and broilers or roasters. Where appearances need not be given much consideration, a temporary colony house can be made of suitable framing and makeshift material, such as old cardboard, wallboard, sheet metal, or odds and ends of lumber, and covered with asphalt-felt paper roofing at a probable cost of $10 to $35. Those who can provide well-built, attractive housing for the home flock with a material cost of $50 to $80 can adhere more closely to the plans mentioned. A well-built, attractive colony house will often be a natural asset to the village or suburban home property. After the war, if the home flock is no longer desired, a well-made portable colony house will have a ready sale value and can be sold and moved elsewhere.

A colony house for layers will need two roosts and a droppings pit 2 feet wide; five wall nests; a feed trough 4 feet long; and a water stand or shelf with a 10-quart galvanized or enameled pail or a crock.

The colony house can be used for brooding and raising the pullets in the spring or fall, and the pullets to be kept for layers can be continued in the colony house afterwards. Since the first colony house will generally be occupied by layers, a second colony house may be needed later for use as a brooder house. Where sufficient yard space is available, an inexpensive range shelter[2] could be provided for hens to make the colony

[1]Working plans and bill of material can be secured by writing the Ohio Agricultural Experiment Station, Wooster, Ohio.
[2]Description and working plans will be sent upon request.

house available for brooding next year's chicks.

The chicks can be brooded with a simple, inexpensive, homemade electric lamp brooder[2] costing $5 to $8.

For 30 select pullet layers next fall, it will be necessary to start 100 unsexed chicks. Since unsexed chicks are about 50-50 pullets and cockerels, and assuming that 85 to 90 per cent will be raised, there would be 40 to 45 cockerels to eat as 2- to 4-pound broilers, or 4- to 6-pound roasters if of the heavier breeds. However, the cockerels should be disposed of as soon as possible if there are near-by neighbors to be annoyed. If the cockerels are kept beyond the broiler stage, the pullets and cockerels will need to be kept separated for best results. In addition to the cockerels, there will likely be 10 to 15 second- or third-grade pullets for table purposes. There will be a lot of good eating from home meat production beginning 10 weeks after the chicks are started. The poultry meat produced should almost pay for the chicks and the feed for both cockerels and pullets. Those fortunately situated with plenty of yard space and green pasturage who will provide an inexpensive 8- by 10-foot wartime range shelter for the cockerels can start 150 to 200 chicks and have broilers and roasters (when not too near neighbors) to sell and thus aid still more in the production of "Food for Victory." Moreover, if 150 to 200 chicks are started, there will be a surplus of ready-to-lay pullets. They should also be sold to avoid the danger of failure of the home egg production project, which will result from keeping more ready-to-lay pullets than there is room for. A 10- by 12-foot colony house will safely accommodate only 30 layers. It should be kept in mind that the beginner's greatest temptation, and the most frequent cause of failure, is overcrowding, which never pays. Of all times, when food is so urgently needed, and when scarce and valuable feed should be used to produce the best returns possible, such needless failures should be avoided.

FEEDING AND MANAGEMENT CONSIDERATIONS

A pound liveweight of broiler or roaster should be realized from 4 to 5 pounds of feed. It will generally require 10 to 12 weeks and 6 to 9 pounds of feed to produce a 2- to 2½-pound broiler, 16 to 20 weeks and 20 to 25 pounds of feed for a 4- to 5-pound roaster, and 25 to 30 pounds of feed to produce a ready-to-lay pullet.

If the birds are confined indoors or to a bare yard, they will require a more complete and expensive feed than when they have access to green pasturage, where a more simple and less expensive ration will serve the purpose.

Table scraps can be used to supplement the chickens' diet. Although food wastage from the table will now be at a minimum, there will still be by-product food material which will be available for chickens. In some instances, this material could be secured from neighbors who have no chickens. Chickens relish table scraps and food by-products, and these can serve as valuable supplements to their diet. Care must be exercised, however, not to overdo a good thing. Unfortunately, this material has its liabilities, and it must be used with two precautions: First precaution is to avoid feeding too much; the poultry raiser should feed only the amount that will be cleaned up within a few minutes once or twice daily. The other precaution is to avoid feeding spoiled food. Spoiled food will not only stop egg production; it may kill some of the layers. Chickens should receive only what would be considered safe for

the family to eat as food. Table scraps not immediately consumed by the chickens must not be permitted to spoil afterwards. This liability can be avoided by feeding the scraps in a separate special feeder, so that any surplus material can be removed a few hours later before spoiling, and by cleaning the feed trough thoroughly before using it again. It is never safe to permit neighbors to feed table scraps to the chickens. It is desirable for neighbors to furnish the scraps if the caretaker of the flock does the feeding, to make sure that the scraps are fit to be fed. Table scraps thrown over the fence to the chickens by neighbors have knocked out many a flock.

The home flock offers a means by which many villagers and suburbanites can produce their own eggs and poultry meat. This is a wartime food project which can well be undertaken at home where the necessary facilities and care can be provided and where municipal regulations permit. Beginners and others can secure reliable information on poultry raising from their County Agricultural Agent, The Extension Service or the College of Agriculture at Columbus, and the Ohio Agricultural Experiment Station at Wooster.

HOW TO MEET WARTIME POULTRY FEEDING PROBLEMS

D. C. KENNARD

Principal wartime poultry feeding problem aside from the general shortage of protein concentrates is the scarcity of the substitutes for green pasturage or green feed generally provided by animal and fish products and high-quality dehydrated alfalfa meal. The solution to the latter problem involves two requirements—conservation of scarce feeds and substitution for those not available.

Conservation of the critical feed products means using them only when and where essential. Best way to conserve is to raise chicks, growing pullets, and roasters on good pasturage, where the animal feed products and dehydrated alfalfa meal can be largely dispensed with. Many poultrymen will find it to their advantage to transfer their layers to temporary quarters (shelters with a roof made of poles, brush, straw, or roofing paper and two sides) where good pasturage can be provided and thus eliminate the use of the animal feed products and alfalfa meal in the feed for layers from May to November. With good pasturage, it is not necessary to use a mash supplement or other poultry feed which contains the special proteins, minerals, and vitamins required for chickens confined indoors. To do so would involve needless expense and use of critical feedstuffs urgently needed for winter feeding, for chickens which must be kept indoors, and for chickens where pasturage or green feed is not available. Consequently, a mash supplement or other feed for chickens on good pasturage should be a simple, less expensive feed mixture designed for that particular purpose, such as follows:

Ration for growing pullets or layers having access to good pasturage

Ingredients	Parts
Whole oats	20
Coarsely ground corn	40
Wheat bran or coarsely ground wheat	12
Meat scraps, 50 per cent protein	10
Soybean oil meal	15
Chick-size oyster shells or high-calcium limestone grit	2
Medium-size granite or quartz grit*	2
Salt	1

Whole corn and/or whole wheat to be kept before the birds at all times.

Good pasturage or succulent green feed to be available at all times.

Oyster shells or high-calcium limestone grit to be kept before the layers.

*The grit can be omitted where range soil contains a generous amount of fine gravel.

This ration can be used as a chick starter when the chicks are on pasturage after the first 2 or 3 weeks by omitting the whole oats and increasing the ground corn to 60. During the past 3 years, it has been used successfully by the Experiment Station at Wooster for starting 5,000 chicks on range and for the growth of 2,000 pullets each year. This ration was satisfactory also for layers on good pasturage.

Substitution for animal feed products can be accomplished by securing the proteins, minerals, and vitamins generally provided by animal feed products from other sources. As some of the substitution products, such as distillers' by-products and special vitamin and mineral products, are not readily available for use by the poultryman or the local feed merchant, the substitutes are often incorporated into ready-made mash supplements containing 26 to 32 per cent protein and proportionate amounts of the special minerals and vitamins to take the place of the animal feed products to be substituted.

Mash supplements are essentially a feed manufacturer's product because of the exacting proportions and necessity for standardized quality and potency of the ingredients. Being concentrates of essential nutrients not generally produced in merchantable form on the farm and not readily available in many sections of the country, the mash supplements lend themselves well to commercial preparation on a large scale and shipment at a minimum cost of transportation to all sections of the country where whole grain and bran and middlings are either produced locally or are readily available. The use of mash supplements involves manufacturing and transporting only 25 to 40 per cent of the total feed requirements for poultry in areas where whole grain, bran, and middlings are produced locally. Where the poultry feed consuming area is a considerable distance from the feed producing areas, the whole grain and the mash supplements can be handled separately. Whole grain can be stored to meet the requirements for a considerable period of time, where-

as the more perishable mash supplements, which require a rapid turnover to avoid undue deterioration of the more unstable vitamins, can be manufactured and transported more in accordance with current demands.

As the difficulty of securing certain feed ingredients, such as milk products, high-quality dehydrated alfalfa meal, meat scraps, tankage, fish meal, bone meal, soybean oil meal, and numerous manufactured poultry feeds, has made it necessary for many poultrymen to use ready-prepared mash supplements to provide the protein, mineral, and vitamin ingredients necessary to supplement the corn, wheat, and oats which farmers and poultrymen either have or can readily procure, the question has arisen, what are some of the best ways to use mash supplements for poultry? The two principal uses of mash supplements for poultry feeding are: the free-choice feeding of whole grain and the mash supplement and the mixing of the mash supplement with coarsely ground corn and/or wheat and whole oats to prepare various mixtures of lower protein content for special purposes.

METHODS OF FEEDING MASH SUPPLEMENTS

Free-choice.—The free-choice feeding of whole corn, oats, and wheat and a mash supplement containing 24, 26, 28, 30, or 32 per cent protein is one method of utilizing the mash supplements.

In feeding layers, it is generally considered advisable to limit the amount of whole wheat fed to that of the total whole corn and oats consumed.

The free-choice method of feeding can be used for growing chickens or turkeys after the first 6 to 7 weeks and for layers. Principal advantage of this type of ration and method of feeding is that there is no grinding or mixing of feed. A disadvantage sometimes experienced with the free-choice feeding of whole grain to layers is that it may increase the liability of feather picking and cannibalism.

Whole oats - mash mixtures (See B mixtures in chart).—Chickens and turkeys prefer whole oats to ground oats. A whole oats—mash mixture is more palatable than a mash which contains ground oats, and there is the saving of the cost of grinding. Of greater importance, however, is the economy of feeding a whole oats - mash mixture versus the free-choice feeding of whole oats. Whole oats often contain varying proportions of light oats and empty hulls. In the free-choice feeding of whole oats, chickens or turkeys will cast aside the light oats and empty hulls, which generally become wastage. This wastage is avoided by feeding a whole oats - mash mixture in which the light oats and empty hulls are readily eaten along with the balance of the feed. Since light oats and empty hulls possess valuable nutritive properties for poultry feeding, it is important that this wastage be avoided.

The value of the poultry ration, as a whole, when based upon the use of a mash supplement, depends primarily upon the quality, amount, and proper balance of the essential proteins, minerals, and vitamins provided by the mash supplement. Any mash supplement which fails to meet these vital requirements may result in failure of the poultry feeding program, regardless of the type of ration and method of feeding employed.

A chart for use of mash supplements to prepare poultry feeds for special purposes

Ingredients	Per cent to be used to prepare mash with a protein* percentage of—						
	18		20		24		16†
	A	B	A	B	A	B	
Mash supplement, 26 per cent protein	50	50	60	60	......	......	40
Corn or wheat, coarsely ground	50	30	40	20	......	......	40
Whole oats	......	20	......	20	......	......	20
Mash supplement, 28 per cent protein	50	50	55	55	80	80	35
Corn or wheat, coarsely ground	50	30	45	25	20	10	45
Whole oats	......	20	......	20	......	10	20
Mash supplement, 30 per cent protein	45	45	50	50	70	70	35
Corn or wheat, coarsely ground	55	35	50	30	30	10	45
Whole oats	......	20	......	20	......	20	20
Mash supplement, 32 per cent protein	40	40	45	45	65	65	30
Corn or wheat, coarsely ground	60	40	55	35	35	10	50
Whole oats	......	20	......	20	......	25	20

*Approximate.
†Whole oats—mash, complete feed mixture.

Purpose of the rations and methods of feeding

18 per cent protein mash (A) or whole oats—mash mixture (B):

A. To be fed as an all-mash starter for chicks or, with an equal amount of whole grain, as a growing or laying mash

B. To be fed as a growing or a laying mash with an equal amount of whole corn and/or wheat

20 per cent protein mash (A) or whole oats – mash mixture (B):

A. To be fed as an all-mash chick starter or broiler mash, a laying mash with whole grain, or a growing mash with grain for turkeys

B. To be fed with whole corn and/or wheat for growing chickens or turkeys, and to layers

24 per cent protein mash (A) or whole oats – mash mixture (B):

A. To be fed as an all-mash starter for turkeys, a mash with the free choice of whole grain for growing chickens and turkeys, and to layers

B. To be fed with the free choice of whole corn to growing chickens and turkeys, and to layers

16 per cent protein whole oats – mash, complete feed mixture:

To be fed as a complete feed mixture without additional grain. This type of ration has been among the best used by the Station during the past several years for the growth of chickens after the first 7 weeks, and for layers and breeders. The principal disadvantage is the additional amount of grinding and mixing required. Nevertheless, the whole oats – mash, complete feed mixture has its advantages for feeding Leghorn hens and heavier breed layers sometimes inclined to consume too much whole grain and insufficient mash for best results in egg production or hatchability of eggs. Moreover, this type of ration often serves as a preventive of feather picking and cannibalism.

Oyster shells or high-calcium limestone grit and hard grit, such as quartz, granite, or fine gravel, need to be kept always available in addition to all the rations described.

THE TRASH MULCH METHOD OF RECLAIMING BROOMSEDGE AND POVERTY GRASS LANDS WITH ALFALFA[1]

H. L. BORST AND R. E. YODER[2]

To the many Ohio farmers who are convinced that alfalfa will not grow on their unproductive, eroded hilly fields, the Soil Conservation Experiment Station and the Ohio Agricultural Experiment Station accomplishment of raising good alfalfa crops on such land is more than eye-opening news. For many a discouraged owner of hilly farm land it is the first step on the way to profitable farming, especially at a time when alfalfa and the livestock it will feed are in such demand.

It is common belief that alfalfa will succeed only on soils at fairly high levels of fertility. Prospective growers have been advised to build up their soils for a rotation or so before attempting alfalfa. They have been advised to put a little alfalfa seed in their meadow mixtures to "prepare" their soil for alfalfa. Consequently, using alfalfa seeded directly as one step in reclaiming impoverished soils may seem revolutionary to many; in a way it is, but constructively so.

Basic requirements for alfalfa are: favorable climate, well-drained soil, nearly neutral soil reaction, an ample supply of mineral elements. Experiments in Ohio and elsewhere show that alfalfa will grow where these conditions are met. Climate is generally favorable for alfalfa anywhere in Ohio. Muskingum and related hill soils are well drained, usually overdrained rather than underdrained. Consequently, when lime and the mineral fertilizers are added in sufficient quantities, these soils make a favorable location for alfalfa.

Another important key to success with alfalfa under these conditions is to protect the land from the destructive forces of rainfall and erosion by leaving the soil covered with a blanket of organic material. Existing vegetation, which usually consists of broomsedge, poverty grass, and weeds, is converted into a surface trash mulch which promotes infiltration, decreases and controls runoff, eliminates erosion, and conserves moisture by decreasing surface evaporation. This protection cannot be provided by plowing, but it can easily be by disking the soil in the proper way while preparing the seedbed for the new seeding. Seeding the meadow directly, without the conventional small grain, eliminates competition by the so-called nurse crop.

Effectiveness of the "trash mulch" method of direct seeding of meadows in controlling soil and water losses resulting from erosion is shown in table 1.

[1]A joint contribution of the Research Division of the Soil Conservation Service and the Ohio Agricultural Experiment Station.

[2]Project Supervisor, Soil Conservation Experiment Station, Zanesville, Ohio; Chief in Agronomy, Ohio Agricultural Experiment Station, Wooster, Ohio, respectively.

TABLE 1.—Erosional losses for two watersheds seeded by two different methods*

Seeding method	Size of watershed in acres	Slope of watershed in per cent	Soil and water losses†	
			Runoff in inches	Soil losses in tons per acre
Conventional—in wheat	1.69	12.7	12.18	21.3
Direct seeding—trash mulch	1.63	21.7	2.64	.1

*Results from North Appalachian Experimental Watersheds, Coshocton, Ohio. Courtesy of Soil Conservation Service.
†Annual soil and water losses for 1943, the year in which the seedings were made.

For 6 years, alfalfa-grass meadows have been established successfully without plowing on eroded, unproductive broomsedge (*Andropogon virginicus* L.) and poverty grass (*Danthonia spicata* L. Beauv.) hills at the Soil Conservation Experiment Station, Zanesville, Ohio. Meadows thus established have produced an average of 2.5 tons of alfalfa-grass hay per acre the year after seeding. The yields obtained are almost 1 ton greater than those from the average hay field in Ohio.

TABLE 2.—Hay yields obtained from alfalfa-grass meadows seeded directly on eroded land without plowing

Meadow mixture seeded	Year sown	Hay yields in tons per acre			
		1939	1940	1941*	1942
Alfalfa, timothy, and orchard grass	1937	2.60	2.77	1.75	2.08
Alfalfa and timothy	1938	3.00	3.25	2.25	3.90
Alfalfa and bromegrass	1940	....	....	1.90	3.35
Alfalfa and orchard grass	1940	....	....	1.75	3.00
Alfalfa and orchard grass	1941	....	....	....	1.60†

*Yields low because of low rainfall
†One cutting only.

Experiments aimed at establishing desirable vegetation on eroded run-down land have been carried on at the Soil Conservation Experiment Station since its establishment. Early studies supported the common belief that establishing a cover on eroded or run-down land in an effort to return it to a productive state is a slow process.

A trial seeding of alfalfa was made on a badly eroded field in the spring of 1936. About one-half the area used was bare; the rest was covered by a sparse growth of poverty grass and some briars. The area, an eroded Muskingum silt loam, had lost most of its topsoil. The soil reaction was very acid, approximately pH 5.4.

To this field, coarsely ground limestone (20 per cent through 100-mesh) was applied at a rate of 4 tons per acre. The land was disked. Twenty per cent superphosphate was put on at 400 pounds per acre. Inoculated, hardy alfalfa was sown at about 15 pounds per acre. When this was done, strips of timothy, smooth brome grass, and orchard grass were sown across the area, which was then cultipacked on the contour.

The resulting seedings were so promising that similar plantings have been made each subsequent year except 1939.

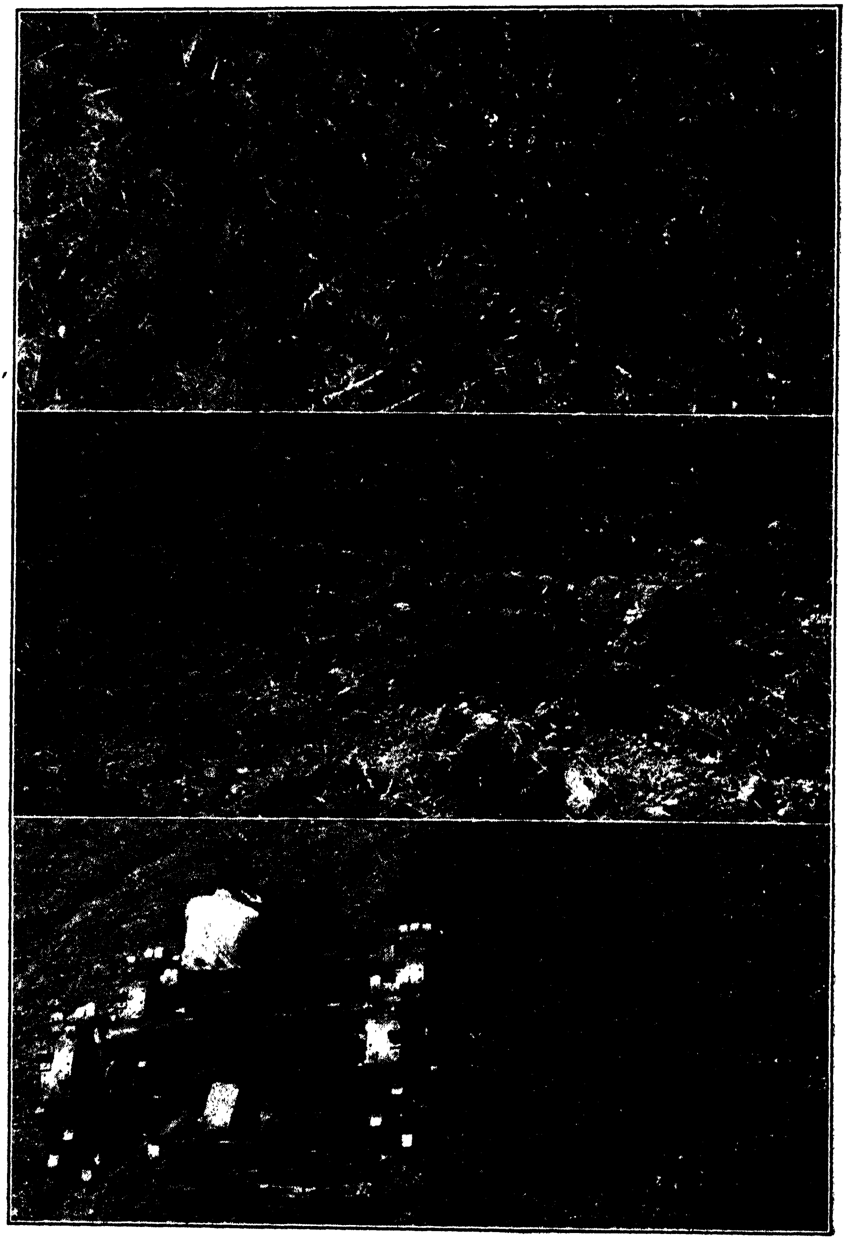

Fig. 1.—*Top to bottom*—Typical poverty grass area before reclamation; seedbed in preparation (further disking will reduce sod clumps and leave protective trash mulch on the surface); reclaimed area with its heavy growth of high-quality alfalfa-grass hay

The area used in 1937 was similar to that treated in 1936. There were some bare spots, but most of the field had a fair growth of poverty grass. The land had previously received some lime, and a small portion of it had been seeded to orchard grass in 1933. Most of the area had been in pasture for more than 20 years. The 1938 area had been cropped last in 1931 and had received some lime previous to that date; at the time of the test it was covered with weeds, except for an occasional patch of thin bluegrass. The five areas used in 1940, 1941, and 1942 had been abandoned for more than 10 years, and none of them had ever been limed; their vegetation was similar to that of the other areas except that more broomsedge was present.

Three cuttings of hay have been made on all areas each year following the year of establishment. First cuttings each year have been mixed hay; second and third cuttings have been nearly straight alfalfa. The hay yields have equaled or exceeded those of the rotation meadows on the Soil Conservation Experiment Station except in 1941, when they were low because of scarce and poorly distributed rainfall.

In addition to the trials at Zanesville, seedings were made at the North Appalachian Experimental Watershed Project, Coshocton, Ohio, in 1940, and at the Ohio Agricultural Experiment Station, Wooster, Ohio, in 1942. Both these were successful. In 1940, several farmers near Zanesville made trial seedings of the sort discussed. Wherever made with proper care, such direct seedings have been successful.

HOW TO DO IT

As a result of the experiments described, the following procedure is recommended for the direct establishment of alfalfa meadows on eroded hill lands:

Apply lime, always enough to neutralize the acidity of the soil or very nearly so, anytime before sowing the alfalfa; the earlier the better. Have the soil tested and take no chances. On most Muskingum soils, at least 3 tons per acre of "agricultural ground limestone" will be needed. If a coarser grade is used, 4 tons or more per acre may be advisable. Be sure to use enough lime.

Disk in late March or early April as soon as the soil can be worked. The soil should be moist, not dry, when disked. It is better to disk the soil a little on the wet side rather than wait too long. The field should be well disked but not worked up into a fine or dusty condition. The old vegetation, which forms the important protection against the forces of erosion, should be left on or near the surface (see fig. 1). It is usually necessary to put considerable weight (200 to 400 pounds) on the disk, particularly if the old vegetation is heavy. If the old vegetation is an extremely heavy growth of broomsedge, it may be desirable to remove enough of it so that the disk can cut through. A tractor disk does a better job than a horse-drawn implement. In fact, heavy sods cannot be cut up without tractor power. Where the old vegetation is thin, double disking (lapped one-half) twice will be sufficient. Do not try to prepare a deep seedbed. In fact, avoid doing so. Areas with a dense growth may require three and even more double diskings. As a somewhat cloddy seedbed is desired, it is not necessary to harrow except possibly with a spring-tooth, which keeps the trash mulch and clods on top of the seedbed. Obviously, tillage operations, particularly the final operation, should be done on the contour.

Fertilize with 0-14-7 or 0-12-12 at a rate of 350 to 400 pounds per acre. Alfalfa requires an abundance of phosphate and potash, as well as lime. Neglecting to supply fertilizer may result in seeding failures.

The fertilizer used in most of the early trials was 4-10-6. Since the opinion was current that alfalfa will thrive only on soils of good fertility, a complete fertilizer with a fair nitrogen content was applied. However, seedings made with phosphate-potash fertilizers in 1941 and 1942 appear as thrifty as those made with fertilizer containing nitrogen; so the use of a nitrogen-carrying fertilizer is not recommended. The fertilizer should be drilled into the soil with a grain drill either before, or at the time, the seed is sown.

Seed with a mixture of alfalfa and grass. The following seeding mixtures (pounds per acre) are suggested:

Mixture No. 1—Alfalfa 10; timothy 6
Mixture No. 2—Alfalfa 10; orchard grass 5
Mixture No. 3—Alfalfa 10; alsike 2; timothy 6
Mixture No. 4—Alfalfa 10; ladino clover 1; timothy 6

Timothy, orchard grass, and smooth brome grass have been used along with alfalfa in these trials. Including a grass in such seedings results in better erosion control, reduces weed growth, increases the yield, helps prevent heaving, and provides a cleaner crop by supporting it above the soil. Orchard grass has proved the most easily established in these trials. Although a good grass for poor soils, orchard grass is not the ideal one to sow with alfalfa for hay, as it matures too early. Only mediocre stands of timothy have been obtained. Tests at Columbus show that additional timothy can be drilled into alfalfa seedings in September with considerable success. Since timothy is somewhat late maturing, it is apt to delay the first cutting of hay, although a new early maturing timothy, Marietta, promises to be more satisfactory. Experience at other experiment stations indicates that smooth brome grass is probably the best grass to mix with alfalfa if the meadow is to be held for more than 2 years and used for grazing purposes. Since satisfactory stands of brome grass have not as yet been obtained in these trials, it is not included in the recommended mixtures. In one seeding, alsike was included with the alfalfa, and it appears that this is a good combination, especially where "seep spots" occur.

Inoculate the legume seed thoroughly. Sow the seed broadcast with any hand seeder or grain drill with a grass seed attachment. Seed and fertilizer can be applied at the same time if the seed tubes are arranged so that the seed falls back of the fertilizer tubes.

Cultipack the seedbed as the last operation before seeding. In the trials described, the areas were cultipacked after seeding, only. Since a compact seedbed is desired, cultipacking before seeding, as well as after, is recommended if time permits. Cultipacking should be done on the contour.

Clip the new meadow seeding to control weed growth. The field may look weedy and unpromising the first season. Clip off the weeds once or twice during the first summer whenever they reach a height of 8 to 10 inches; otherwise growth may become so rank that the alfalfa is choked out. This clipping should be done before mid-September if good

fall growth for winter protection is desired.

In a very favorable season, considerable forage growth may be made the first season. It is better to leave this on the field. However, if any hay is made, it should be cut before September 15.

From these trials, it seems that alfalfa holds promise as a crop to utilize profitably, and at the same time rejuvenate, eroded Muskingum and related soils. Alfalfa has several characteristics which make it an exceptionally valuable soil-reclaiming crop for eroded hillsides if generous amounts of lime and fertilizer are used. Its root system goes deep for nutrients and moisture and adds many pounds of highly nitrogenous organic matter. The water-absorbing capacity of the soil is improved by this organic matter and by the openings left by decaying roots. Once established, alfalfa, unlike red clover, lives for several years, thus eliminating the necessity for frequent tillage of the soil.

Although starting alfalfa sounds expensive, it really is not. Lime is a necessity in most of eastern Ohio whether alfalfa is grown or not. The cost of the failure to use enough lime in eastern Ohio greatly exceeds the cost of the lime required to correct the situation. The fertilizer required is only a little more than should be used for wheat, a crop which returns very poor yields on such soils. The seed expense is not out of line when the long life of an alfalfa-grass meadow is considered. In favorable seasons, some hay or pasture can be had the year the seeding is made. Forage returns the year following sowing should more than cover the cost of establishing the crop. It is well to remember that a ton of good early cut alfalfa hay contains as much protein as a ton of bran. Areas sown in the manner described can be harvested for hay or grazed off. They should fill a real need for high-quality forage during midsummer, when permanent bluegrass pastures are apt to be short.

The "trash mulch" method of direct establishment of alfalfa-grass meadows on the "worn-out", badly eroded hill lands of eastern and southeastern Ohio possesses much promise as a means of restoring the productiveness of such lands. Farmers are urged to try the method, in a small way at first, to see how it works under their particular conditions. If there is sufficient vegetation on the ground to be converted into an effective "trash mulch", hillsides too steep for row crop cultivation can be converted immediately into high-quality forage-producing areas without creating an erosion problem.

COMPARATIVE INJURY TO TOMATO PLANTS BY INGREDIENTS OF FUNGICIDAL SPRAY AND DUST MIXTURES

J. D. WILSON

The injurious effects of fungicidal spray and dust materials on many plants have been observed by numerous investigators. Bordeaux mixture, its counterpart in monohydrated copper sulfate – hydrated lime dust, and many other spray and dust formulas may cause various types of plant injury. These injuries include hardening, drying, burning, deformation, and even shedding of leaves; stunting, defloration, and sometimes death to growing points and flower parts; russeting and deformation of fruit; growth abnormalities; an increase in water requirement; retardation in maturity; and reduction in yield. Injury occurs especially during periods of weather specific for different hosts and spray materials and periods of low soil moisture (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11). Growers, and even processors of fungicides, sometimes mix various ingredients without sufficient consideration of possible effect on the host plant.

Observations made over a period of years while testing the effectiveness of various spray and dust formulas in the control of vegetable diseases (8) prompted the present series of tests on the phytotoxicity of various materials to tomato plants.

MATERIALS AND METHODS

Leaves of tomato plants grown in the greenhouse during the winter are less firm and have a higher water content and thinner epidermis than those grown in field or garden in the spring. Indoor plants are, therefore, more subject to injury from spray and dust materials than plants grown outdoors. This greater sensitiveness made greenhouse tomato plants more desirable for a study of the phytotoxicity of spray and dust ingredients, because the magnification of any injurious action insured a more accurate classification of the different materials than could be secured on

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9. Wilson, J. D., and W. D. Moore. 1942. Comparison of sprayed tomato plants grown as seedlings in Georgia and Ohio. Ohio Agr. Exp. Sta. Bimo. Bull. 27: 17-25.
10. Wilson, J. D., and H. A. Runnels. 1937. The effect of various spray materials on tomato transplants. Ohio Agr. Exp. Sta. Bimo. Bull. 22: 58-65.
11. Wilson, J. D. 1935. New treatments for cucumbers. Ohio Agr. Exp. Sta. Bimo. Bull. 20: 68-75.

outdoor plants, on which variations in injury might appear only as a reduction in growth or yield (5, 8). If a given ingredient or mixture causes no injury in the greenhouse, it is not likely that it will in the field, although there are some exceptions. If a material is definitely injurious to greenhouse-grown tomato plants, it is very likely that it will cause some injury under certain environmental conditions in the field.

Tomato plants used in this experiment were started at weekly intervals so that seedlings of the desired size (about 3 inches in height) might be available whenever a new series of tests was to be started.

The plants of a given series were treated for the first time about 10 days after they had been transplanted into 4-inch pots. The first treatment was followed by three others at weekly intervals. At the end of this time, the plants were allowed to grow for 1 more week before they were examined for possible injury and measured for height and weight. Five plants were used for each treatment, and at least two groups of check plants were set aside in each experiment. Thus, a series that included 10 different treatments and two check groups involved the use of 60 plants. One set of the checks was sprayed with water; the other received no treatment.

The relative position of the plants in the bench holding each group series was changed at 2-day intervals to reduce the influence of variations in light, temperature, and crowding on growth. Plants were watered without wetting the foliage.

The materials used in these tests were applied both as sprays and as dusts. When used as dusts, the inert ingredients (fillers, diluents, or carriers) were applied without dilution; as sprays, they were used at the rate of 10 pounds in 100 gallons of water. Turgitol (1-1,000) was used as the wetting agent in all spray formulas. Fixed coppers used in these tests consisted chiefly of basic chlorides, basic sulfates, and certain oxides. The copper compounds were diluted to contain 7 per cent of copper calculated as the metallic equivalent. Thus, a compound that contained 50 per cent of copper as metallic was mixed with a diluent in a 14-86 formula. In spray formulas, the copper compounds were used in dilutions that provided 2 pounds of copper as metallic in each 100 gallons of spray mixture. Although used without dilution in the diluent test, bentonite was also used at the rate of 15 pounds per 100 pounds of mixed dust; it was used in sprays at the rate of 10 pounds in 100 gallons of water. Supplemental materials, such as insecticides, whether in spray or dust formulas, were used at the recommended rate for field practice. Spray formulas were applied with a large atomizer operated at 75 pounds of air pressure.

Dusts were applied in a dust tunnel about 8 feet long and 3 feet square. The material was introduced into one end of the tunnel by passing it through a specially constructed duster.[1] The dust was fed into the air blast from the duster fan and thence into the tunnel at a definite rate per minute. The plants were placed one at a time on a small revolving platform (driven by a phonograph motor and gear assembly) which was located directly in the air-dust cone about 4 feet from the duster nozzle. There were two groups of dusted plants. One was wetted in a chamber filled with cool steam simulating a heavy dew before being dusted. The other was dusted dry and placed in the dew-forming chamber immediately afterward. In both treatments the

[1]Furnished by the Root Manufacturing Co., Cleveland, Ohio.

dust was brought into intimate contact with the leaves in the presence of water before the plants were set aside. When the leaves became dry they remained so until the plants were treated again 1 week later.

The five plants receiving a single material were dusted very similarly, but not all dusts clung to the foliage in the same amount, and some mixtures collected to a greater extent on wet foliage than on dry. Wet plants were left in the dust blast only about half as long as the dry ones in an effort to equalize the deposits built up by the two methods.

RESULTS

Leaf drop, a designation of injury that appears in the following tables, should not be considered as any more than mildly condemning a material which caused the potted plants of these experiments to shed their lower leaves. The plants grew in 4-inch pots over a period of about 5 weeks, and unless favorable growth conditions are maintained at all times, there is always a possibility that a plant may respond to some temporary deficiency or excess by dropping some of its leaves. However, since the check plants (treated with nothing but water) and some of the plants treated with the ingredients tested failed to shed any leaves, this response of some of the treated plants (see fig. 3), which was very marked in certain instances, was accepted as a legitimate (1, 3), if somewhat indefinite, criterion of injury.

Deformation of leaves (see fig. 2, 4, and 5), which manifested itself as curling, one-sided growth and torn, ragged margins, was usually initiated by a drying and burning of the edges. When this desiccation of the young tissues was severe enough, elongation of the central stem was halted by death of the growing point, which was usually followed by the production of axillary shoots at the leaf bases (see fig. 5). This type of injury often follows the application of Bordeaux mixture to young tomato plants, formerly a disease-control practice of growers of tomato plants in the northern states and Georgia (5, 8, 9, 10).

Other injuries observed in these experiments included a definite yellowing of leaves and chlorosis.

In the first experiment, the plants were treated with a number of diluent materials, such adhesives as wheat flour and bentonite, and hydrated lime. Four treatments were applied at weekly intervals, and 4 weeks after the initial application was made, the height of the plants was determined. Plants were then examined for the various types of injury and finally cut at the soil line and weighed. Data relative to this experiment are given in table 1.

Some of the materials included in this first experiment were found to be more injurious when dusted on wet plants than on dry ones, but hydrated lime was most injurious when applied to dry plants that were wetted immediately after treatment (see fig. 4). In general, the materials listed in table 1 were more injurious when applied as an atomized spray in a concentration of 10 pounds in 100 gallons of water than when dusted on either wet or dry plants, as is shown by the average weight and height of sprayed plants compared with dusted ones. The growth values in this experiment were similar for the two types of dusting.

Some of the materials listed in table 1, such as the three talcs, gypsum, and wheat flour, caused very little injury. The clays were definitely more injurious than the talcs. Both the clays caused considerable injury when applied as sprays (10) and some leaf deformation when applied as dusts. Gypsum was the safest of the materials tested in this first series. Wheat flour was non-injurious except for a peculiar downward curling of the leaves on plants dusted when wet, apparently caused by the heavy, stiff crust of dried flour paste.

Bentonite and hydrated lime were by far the most injurious of the materials used in this first experiment. The growing points of many of the plants treated with hydrated lime were injured (see fig. 4). Some of the plants treated with bentonite were also considerably injured (see fig. 2 and 3). As a result of these injuries many of the affected plants became severely deformed as they continued to grow slowly (see fig. 2). Hydrated lime caused little or no injury when dusted on wet plants, but severe injury when plants were dusted dry and then wetted, as can be seen in figure 4. Bentonite was more injurious when applied to wet than to dry plants (fig. 3), probably because of the heavier accumulation of material on wet plants, as with flour.

Thus, observations and growth data indicate that the common talcs, gypsum, and whiting can be used in fixed copper dust formulas with little danger of injury from the diluent fraction. There is likely to be more danger with the clays and bentonite. Hydrated lime is not used with fixed copper but is mixed with monohydrated copper sulfate to make copper-lime dust, and when used alone or in excess, it is one of the most injurious of the materials commonly applied to plants for the control of plant diseases.

TABLE 1.—Influence on growth of tomato plants of various fungicide ingredients applied in undiluted form as dust on wet and dry plants and applied as a spray (10-100)

Ingredient	Dusted wet		Dusted dry		Sprayed	
	Growth rating	Form of injury	Growth rating	Form of injury	Growth rating	Form of injury
EM-23 Talc	1	None	3	Sl LD	1	Sl LD
Pyrax ABB	7	Sl LD	7	Sl LD	6	Sl LD
Loomkill Talc	8	Sl LD	4	None	3	Sl Def
Crown Clay	10	Md LD Sl Def	8	Sl LD	9	Md LD Md Def
Cherokee Clay	9	Md LD	10	Sv LD Sl Def	5	Sl LD Md Def
Whiting	6	Sl LD	5	Sl LD	10	Sl LD Sl Def
B. F. Gypsum	5	None	6	None	4	None
Bentonite	11	Sv LD Sv Def	9	Md LD Md Def	7	Md LD Md Def
Wheat flour	3	Sl Def	2	None	8	Sl LD
Hydrated lime	4	Sl LD	11	Sv LD Sv Def	11	Md LD Sv Def
Check	2	....	1	....	2	....
Average height (in.)	7.0	....	7.1	....	6.8	....
Average weight (gm.)	9.5	....	9.5	....	8.5	....

Note: The following symbols are used in all tables to indicate grades of injury: Sl, slight, Md, medium, and Sv, severe. Leaf drop is designated by LD. Deformation of leaves following tissue injury is designated as Def. Marginal injury or burning of leaves is designated as MI, and injury to growing point is shown as PI. Formation of axillary shoots, which often follows injury to growing point, is designated as Ax. The stunting that often accompanies other forms of injury is indicated as St. Yellowing is indicated by YEL.

Fig. 1.—Comparative growth of tomato plants treated with EM Talc and with water only

Left to right the plants were sprayed with talc in water, dusted with talc while foliage was wet, dusted while dry, and sprayed with water only.

Fig. 2.—Comparative effect of various materials sprayed on tomato plants

Left to right the plants were sprayed with lime, bentonite, whiting, and EM Talc.

Fig. 3.—Effect of bentonite on the growth of tomato plants

Left to right the plants were sprayed with bentonite in water, dusted with bentonite when the foliage was dry, dusted with bentonite when foliage was wet, and sprayed with water only.

Fig. 4.—Effect of hydrated lime on the growth of tomato plants

Left to right the plants were sprayed with lime in water, dusted with lime when the foliage was dry, dusted wet, and sprayed with water.

What happens when a fixed copper (copper oxychloride by the Harshaw Chemical Co.) is diluted with the materials listed in table 1 is shown by the data of table 2. Fourteen pounds of copper oxychloride were mixed with 86 pounds of the various diluent materials in the preparation of the dust formulas. The spray formulas were prepared on the basis of 4 pounds of the fixed copper and 10 pounds of the diluent in 100 gallons of water. The application procedure was the same as that used in the previous experiment (data in table 1).

Results, from the standpoint of injury caused to treated tomato plants, were not greatly altered in most instances by the presence of copper oxychloride in the formula. The average growth of plants dusted while dry and then wetted was less than that of plants dusted when wet or sprayed. The depression of growth of the dry plants was rather surprising, and the cause is not clear.

Addition of copper to the three talcs used in this experiment did not increase injury, a result which indicates that these materials are comparatively safe diluents. The two clay formulas were just slightly more injurious after copper was added to them, and it is likely that certain combinations of a fixed copper and clay might cause injury. Combinations of copper oxychloride and whiting or B. F. Gypsum proved to be inactive, and these two materials can be regarded as comparatively safe. Whiting has been found more active than gypsum in certain instances, perhaps because of its more alkaline reaction (12). The bentonite – copper oxychloride formula was even more injurious than bentonite alone, and this evidence, together with more to be given later, indicates that bentonite activates certain of the fixed coppers to such an extent that plant injury is increased. Injury from its use on tomatoes is not usually apparent in the field, however. A mixture of wheat flour and copper oxychloride proved to be slightly injurious when applied as a dust, but no harmful effect was observed from the spray. The injurious effect of hydrated lime was only slightly accelerated by the addition of a fixed copper, but since this combination is not commonly used, the results are of only academic interest.

TABLE 2.—Effect of various ingredients plus copper oxychloride on the growth of tomato plants

Ingredient to which copper oxychloride was added	Dusted wet		Dusted dry		Sprayed	
	Growth rating	Form of injury	Growth rating	Form of injury	Growth rating	Form of injury
EM 23 Talc	2	None	6	None	1	None
Pyrax ABB	7	Sl Def	5	Sl LD	4	Sl Def
Loomkill Talc	9	Sl LD	8	Sl LD	5	None
Crown Clay	3	Sl LD	3	Sl LD Sl Def	9	Sl St Sv Def
Cherokee Clay	10	Sl LD Sl Def	4	Sl LD	6	Sl Def
Whiting	6	None	9	Sl Def	8	None
B. F. Gypsum	8	None	7	None	7	None
Bentonite	11	Md LD Md Def	11	Md LD Sv Def	11	Md St Sv Def
Wheat flour	4	Sl Def	1	Sl Def	2	None
Hydrated lime	5	Sl LD Sl Def	10	Md LD Sv Def	10	Md St Sv Def
Check	1	....	2	....	3	....
Average height (in.)	7.1	....	6.5	....	6.9	....
Average weight (gm.)	10.3	....	8.7	....	10.6	....

12. Wilson, J. D., and Frank Irons. 1942. Specifications of some of the ingredients commonly used in dust mixtures. Ohio Agr. Exp. Sta. Bimo. Bull. 27: 26-41.

A rather definite stunting of some of the sprayed plants was observed in this experiment. This stunting always accompanied a severe case of plant and leaf deformation, and, therefore, may have been caused merely by a reduction in leaf area. Leaf drop was similar whether the plants were treated with the diluents only or the mixtures with copper. Deformities of leaf and stem were slightly more severe when the mixtures were used. This greater injury was probably an additive effect in which injury due to the copper compound alone, or as it was activated by the diluent, increased that caused by the diluent alone.

The fixed coppers have been used in a wide range of formulas in field applications for the control of various vegetable diseases. These formulas have included numerous adhesives, diluents, and supplemental insecticides, and it is not surprising that some of them have been injurious to the host plants. A number of these materials, such as bentonite, Cherokee Clay, EM Talc, B. F. Gypsum, D. C. F. Whiting, ground derris (rotenone source), and Alorco (a synthetic cryolite), were mixed with various fixed coppers and applied to tomato plants as sprays and dusts in this series of experiments. The procedure was much the same as that

TABLE 3.—Comparative effect on growth of tomato plants of fixed coppers mixed with Cherokee Clay or bentonite

	Bentonite				Cherokee Clay			
	Dusted		Sprayed		Dusted		Sprayed	
	Growth rating	Leaf injuries	Growth rating	Leaf injuries	Growth rating	Leaf injuries	Growth rating	Leaf injuries
Brown cupric oxide hydrated	7	Sl LD	5	Md LD Sl Def	6	Sl LD Sl Def	5	Md LD Sl Def
Red Cuprocide	3	Sl LD	12	Sl Def	2	Sl LD	2	Sl LD
Yellow Cuprocide	8	Sl LD	13	Sl LD Sl Yel	3	Sl LD	7	Md LD
Tribasic	13	Sl LD	7	Sl LD	8	Sl LD Sl Def	6	Sl LD Sl Def
Basicop	12	Sl LD	9	Md LD	1	Sl LD	1	Sl LD
Spraycop	11	Md LD	11	Md LD	11	Md LD	15	Md LD Sl M I, P I, Md Ax
Copper oxychloride	1	Sl LD	4	Sl M I Sl LD	12	Md Def Sl LD	3	Sl LD
Copper A Compound	9	Sl LD	8	Sl M I	5		9	Sl LD
Cupro-K	5	Sl LD	2	Sl LD	13	....	13	Sl LD
Copper oxychloride-sulfate (COC-S)	10	Sl LD	10	Sl LD	9	Sl LD Sl Def Sl LD	8	Sl LD
Basic copper arsenate	6	Sl LD	6	Sl LD	7	Md LD	12	Md LD Sl M I, Sl Ax
Copper oxalate	4	Sl LD	3	Sl LD	10	Sl M I	11	Sl LD
Coposil	16	Md LD Md Def	16	Sv LD Md Def	16	Md LD Sv Def	17	Sl LD Sv M I, P I, Md Ax
Copper Hydro 40	14	Sl LD	14	Sl LD	14	Md LD Md Def	10	Sl LD Sl M I, Md Ax
Bordow	15	Md LD	15	Sl LD	15	Md LD Sv Def	14	Md Def, Md M I, P I, Sv Ax
Bordeaux mixture	17	Md LD Md Def	17	Md LD Md Def	17	Md Def Md M I	16	Md Def, P I, Md Ax
Check	2	....	1	....	4	....	4	....
Average height (in.)	6.7	....	6.7	....	6.8	....	6.7	....
Average weight (gm.)	11.6	....	10.6	....	10.0	....	9.0	....

TABLE 4.—Comparative effect of various diluents and supplemental materials on the injury which the fixed coppers may cause when sprayed or dusted on tomato plants

Ingredient	E. M. Talc			B. F. Gypsum			D. C. F. Whiting			Ground derris root			Alorco		
	Growth rating	Foliage injuries: Sprayed	Foliage injuries: Dusted	Growth rating	Foliage injuries: Sprayed	Foliage injuries: Dusted	Growth rating	Foliage injuries: Sprayed	Foliage injuries: Dusted	Growth rating	Foliage injuries: Sprayed	Foliage injuries: Dusted	Growth rating	Foliage injuries: Sprayed	Foliage injuries: Dusted
Brown cupric oxide hydrated	9	....	....	10	....	Sl LD	12	Sl LD	Md St Md Ax	7	....	....	12	....	Sl LD
Red Cuprocide	4	....	....	9	....	Sl LD	9	Sl LD	Md Yel	9	....	....	1	....	....
Yellow Cuprocide	5	....	....	8	Sl Yel	Sl Yel	13	Md Yel	Sv Yel	8	....	....	5	....	Md LD
Tribasic	7	....	....	3	....	....	1	....	....	4	....	....	6	....	....
Basicop	2	....	....	2	....	....	8	Sl Yel	Sl LD	6	....	....	8	....	....
Spraycop	10	....	....	5	Sl LD	Sl LD	7	....	Sl M I	12	Sl LD	....	9	....	Sl LD
Copper oxychloride	11	....	....	12	....	Sl LD	11	....	....	2	....	....	10	....	....
Copper A Compound	14	....	Sl LD	6	....	....	6	....	Sl Def	10	Sl LD	Sl LD	2	....	Sl LD
Cupro-K	12	....	....	7	....	Sl LD	2	....	....	14	Sl LD	....	14	Sl LD	Md LD
Copper oxychloride-sulfate (COC-S)	6	....	....	1	....	....	10	....	....	5	....	....	11	....	....
Basic copper arsenate	1	....	....	15	Sl Yel	Sl Def	4	....	....	11	....	Sl LD	13	....	Md LD
Copper oxalate	13	....	....	13	....	Sl LD	16	Sl Def	Sl Yel	13	....	....	7	....	Sl LD
Coposil	15	Md St	Sl Def	14	Sl Def	Md LD Md Def	17	....	....	16	Sl LD	Sl M I	15	Md LD Sl Def	Sl LD Sl Def
Copper Hydro 40	8	....	....	11	....	....	5	....	....	1	....	....	3	....	....
Bordow	17	Sl St	Sl St	16	Md LD	Sl Def	14	Md LD	Sl Yel	15	Sl Def	Md LD Sl Def	16	....	Md LD Sl Def
Bordeaux mixture	16	Sl Def	Sl St Md Def	17	Md Sl Def	Md LD Sl Def	15	Sl Def Sl Ax	Md LD Md Def	17	Md Ax Sv Def	Md LD S. M I	17	Md LD Md Def	Sl LD Md Def
Check	3	....	....	4	....	....	3	....	....	3	....	....	4	....	....

described for the two previous experiments, with the exception that the dust mixtures were applied in one way only. The plants were slightly dampened in the dew chamber, dusted in the dusting tunnel, placed again in the dew chamber, and then set aside for observation. Data relative to these experiments are shown in tables 3 and 4.

The copper compounds listed in tables 3 and 4 were used in spray formulas at whatever quantity would provide 2 pounds of copper (stated as the metallic equivalent) in 100 gallons of spray material (4 pounds of 50 per cent compounds like Tribasic or COC-S). In dust formulas they were used in such quantity that the mixture contained a metallic copper equivalent of 7 per cent (14 pounds of a 50 per cent compound like Basicop or 20 pounds of a 35 per cent material like Spraycop). Cherokee

Fig. 5.—Comparative influence of the three most injurious copper-containing materials tested on the growth of tomato plants

From left to right the plants were sprayed with Coposil plus bentonite, Bordeaux mixture, Bordow, and water only.

Fig. 6.—Comparative influence of the copper oxychlorides plus bentonite on the growth of tomato plants

From left to right the plants were sprayed with copper oxychloride by Harshaw, copper oxychloride-sulfate by Harshaw, Copper A Compound by Grasselli, Cupro-K by Röhm and Haas, and with water only.

Clay, bentonite, EM Talc, B. F. Gypsum, and whiting were used at 10 pounds per 100 gallons in spray mixtures and in dust formulas as the difference between the amount of any copper compound used and 100 pounds (14 pounds of Basicop and 86 pounds of diluent). Ground derris root and Alorco were used in spray formulas with the different copper compounds at 5 pounds per 100 gallons. In dust formulas, derris root and Alorco were used as 15 and 20 per cent, respectively, of mixtures that also contained one of the copper compounds and EM Talc.

It was expected that bentonite, which caused some injury when used alone and with copper oxychloride, would also be injurious with many of the copper compounds listed in table 3. Some injury did occur in many instances and was usually more severe in spray than in dust applications. In this series of tests with bentonite, brown cupric oxide hydrated was the most injurious of the oxides of copper used (see table 3 and fig. 7). Spraycop caused slightly more damage to foliage than the other basic sulfates, Basicop and Tribasic. There was little difference in the oxychlorides, which included Cupro-K, copper oxychloride by the Harshaw Chemical Co., and copper A Compound (see fig. 6). COC-S, a mixture of the chloride and sulfate, was comparatively noninjurious. Basic copper arsenate and copper oxalate were similar to the chlorides in the amount of foliage injury that they caused when mixed with bentonite. The Copper Hydro 40 plus bentonite mixture was very injurious. The injury which Coposil sometimes causes to young tomato plants, even in the field (9), was accelerated by the addition of bentonite (see fig. 5). Bordow, a dry Bordeaux prepared with magnesium hydrate, was more injurious when mixed with bentonite than were any of the fixed coppers tested, with the possible exception of Coposil, and it caused nearly as much injury as did Bordeaux mixture (see fig. 5).

When Cherokee Clay was combined with the various copper compounds listed in table 3, the foliage injury resulting was considerably less in most instances than that caused by mixtures of bentonite and the same

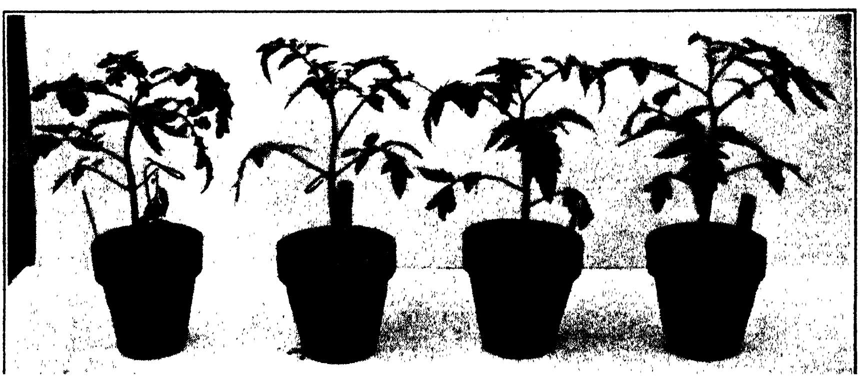

Fig. 7.—Comparative growth of tomato plants sprayed with three oxides of copper plus bentonite

From left to right the plants received brown cupric oxide hydrated by Harshaw, red Cuprocide and yellow Cuprocide by Röhm and Haas, and water only.

copper compounds. When the clay-copper mixtures were applied as dusts, only Coposil and Bordeaux mixture caused any marked deformity of the leaves, although there was some leaf drop with every one. Leaf drop was only slightly more marked among the sprayed plants, but other types of leaf injury were definitely more severe on sprayed than on dusted plants. Yellow Cuprocide plus clay caused some yellowing of the foliage, although the plants were otherwise normal in appearance.

The five materials listed at the top of table 4 were mixed with the various copper compounds shown in the first (left) column of the same table in the proportions and formulas previously described. None of these five materials was as injurious when mixed with the coppers as were bentonite and Cherokee Clay. Eastern Magnesia Talc (EM23) apparently caused little or no activation of the copper compounds in the sense of accentuating their capacity to cause injury to foliage. Even leaf drop was practically absent in this particular series. Coposil caused a slight stunting of growth, as did Bordow and Bordeaux mixture. The relative average growth of the plants treated with the different combinations is indicated by the values given under "growth rating." In this rating the largest plants were given the value of 1 and the smallest the value of 17. These values were arrived at in the data of table 4 by averaging the height and weight values (one for each of five plants, or 10 values in all) for each treatment. The plants treated with basic copper arsenate were the largest in the EM Talc series, followed, in turn, by those treated with Basicop and with water only. The smallest plants received Bordow, and these were followed, in turn, by those treated with Bordeaux and Coposil. Plants receiving Coposil, Bordow, and Bordeaux mixture were generally the smallest throughout the different series in tables 3 and 4, regardless of what diluent, adhesive, or supplement was mixed with these materials.

Gypsum caused somewhat more injury in combination with the various copper compounds than did EM Talc, and whiting increased foliage damage still more. The mixtures with

Fig. 8.—Comparative effect of basic copper sulfates plus bentonite sprayed on tomato plants

From left to right the plants were treated with Spraycop by General Chemical, Tribasic by Tennessee Copper, Basicop by Sherwin-Williams, and water only.

ground derris root were comparatively noninjurious, as might be expected, since the proteinaceous materials of the derris root depress copper injury. Alorco proved to be somewhat more injurious than derris root or EM Talc, but it did not cause as much injury in combination with most of the copper compounds as did Cherokee Clay or whiting.

When the copper compounds were ranked on the basis of growth rating and degrees of foliage injury in spray and dust applications, brown cupric oxide hydrated and yellow Cuprocide were responsible for a similar degree of injury. Red Cuprocide caused less injury than either the brown or yellow oxides. Of the three basic sulfates, Basicop was the least injurious in an average of all seven trials. Spraycop caused considerably more injury than Tribasic. From the standpoint of injury, there was little to choose between the three chlorides of copper. Cupro-K has seldom caused much injury in field tests, and on the basis of these greenhouse tests, it probably can be classified as less injurious than copper oxychloride by the Harshaw Chemical Co. or Copper A Compound. COC-S was less injurious in most instances than any of the oxychlorides. Basic copper arsenate, copper oxalate, and Copper Hydro 40 were somewhat similar in the amount of injury they caused, with one or the other of them ranking above the other two in different trials. Coposil was definitely the most injurious of the 14 fixed coppers used in the five trials of table 4, just as it was when used with bentonite or Cherokee Clay. Bordow and Bordeaux mixture, in both of which the copper is present chiefly as one or more of the hydroxides, were both very injurious to the tender greenhouse plants. There is usually an excess of magnesium or calcium hydroxides present in these materials, and these hydroxides are also capable of causing considerable injury to plants.

SUMMARY

Some mixtures commonly applied as fungicides for the control of vegetable diseases will injure tender plants. Bordeaux mixture is one of these. An injury such as marginal burn of the leaves may be quickly apparent; another form may appear only near the end of the season as a stunting of plants or a reduction in yield.

Tomatoes are especially subject to injury by fungicidal mixtures applied either as sprays or as dusts. Phytotoxic materials may injure tomatoes in various ways, such as marginal burning of leaves followed by deformation as the leaf grows; death of stem growing points, resulting in an early and excessive formation of axillary shoots; damage to blossoms; stunting of growth; and, in some instances, yellowing or chlorosis of leaves.

The phytotoxicity of a number of ingredients of fungicidal spray and dust formulas, particularly of dust mixtures, singly and in various combinations, was tested on tomato plants grown in a greenhouse during the winter. Plants were both sprayed and dusted, and dusts were applied to both wet and dry plants in two of the experiments.

Two clays were the most injurious of a group of diluent materials, followed by whiting and three talcs. Gypsum caused the least injury of this group. Wheat flour, which is sometimes used as an adhesive, was much less injurious than bentonite. Hydrated lime, which is used in the preparation of Bordeaux mixture and copper-lime dust, was one of the most injurious of the individual materials tested. Sprays were usually more injurious than dusts.

When a copper oxychloride was added to the diluent materials tested, the degree of injury was increased slightly in some instances. The talc mixtures were again safe, as were gypsum and whiting. The injurious effect of the clays was increased somewhat, and that of bentonite was increased considerably. The hydrated lime mixture was also very injurious, though its effect was changed but little by adding the copper compound.

A series of 14 fixed coppers, a prepared mixture of magnesium hydrate and copper sulfate known as Bordow, and Bordeaux mixture were mixed in turn with bentonite, Cherokee Clay, EM Talc, B. F. Gypsum, whiting, ground derris root, and Alorco, and these mixtures were dusted and sprayed on tomato plants. Practically all the copper-containing compounds were most injurious when mixed with bentonite and caused the least injury when mixed with derris root or EM Talc. Cherokee Clay mixtures caused considerable injury, followed, in decreasing order, by Alorco, whiting, and B. F. Gypsum mixtures. If the average injury caused by the different copper-containing compounds with each of the added materials is considered, the greatest injury to tomato plants was caused by Bordeaux mixture, Bordow, and Coposil, in descending order. Basicop, Tribasic, and COC-S were, perhaps, the least injurious, but these were followed closely by Cupro-K, basic copper arsenate, red Cuprocide, Copper Hydro 40, and copper oxalate. Spraycop, yellow Cuprocide, copper oxychloride, brown cupric oxide hydrated, and Copper A Compound caused an intermediate amount of injury which varied considerably with the different materials used with them.

None of the materials listed in these experiments should be condemned or dropped from use simply because of injury caused to the tender tomato plants used in these trials. This study was made primarily for the purpose of classifying some of the ingredients of spray and dust mixtures on the basis of their potential capacity to cause injury under conditions favorable for its occurrence. This information should give a better understanding of some of the responses observed in the field.

DETERMINING COMBINE LOSS ON THE FARM

C. B. RICHEY

Combines are often operated in poor adjustment because operators do not realize how much grain is being lost. The common method of checking adjustment is to inspect a handful of straw and chaff collected at the rear of the machine. It is very difficult, however, to estimate a machine's losses at all accurately by this method, and many times the operator does not detect serious losses. There has been great need for a better method, one which would be more accurate and yet simple enough to require a minimum of equipment and be practical for use on the farm.

Such a method was developed during the 1941 combining season in con-

nection with combine efficiency tests conducted by G. W. McCuen and E. A. Silver of the Department of Agricultural Engineering.

In this method, a shallow pan of the correct size is thrown on the ground at the rear of the moving combine just ahead of the falling straw and chaff. The pan thus catches the straw and chaff which would normally fall on the area it covers. The straw is shaken over the pan to remove loose grain, and the chaff is winnowed. The grain collected is placed in a measuring container, and the relationship between the volume indicated in the measure and the area of the pan is such that the volume collected indicates bushels of grain lost per acre. Since a bushel is a volume measurement, the same measuring container can be used for all crops.

The measuring container can be of any type suitable for the purpose. Most easily obtainable is probably a medicine measuring glass, which can be secured from a drugstore for about 15 cents. It has tablespoonfuls marked on the side. It is somewhat fragile, but a round cardboard container of the type used for medicinal powders can be secured from the drugstore to protect the glass.

One tablespoonful has a volume of 0.902 cubic inch, and since a bushel is 2,150.4 cubic inches, a tablespoonful is $\frac{0.902}{2,150.4}$ or $\frac{1}{2,384}$ of a bushel. Therefore, if 1 tablespoonful of grain was lost in combining $\frac{1}{2,384}$ of an acre, this would indicate a loss of 1 bushel per acre. Any other desired unit of volume measure can be used, but, of course, the size of the sampling pan must be calculated accordingly.

An area of $\frac{1}{2,384}$ of an acre is equal to 2,631 square inches, and the sampling pan must catch the straw and chaff which will fall while 2,631 square inches are being combined. If the width of cut of the combine is known, the distance traveled to cut 2,631 square inches can be calculated, and the pan should be made this wide and long enough to extend across the area on which straw and chaff are deposited at the rear of the machine. Such a pan can catch the material falling from the combine while $\frac{1}{2,384}$ of an acre is being cut. Table 1 shows the proper sizes of sampling pans for popular sizes of combines.

TABLE 1.—Sampling pan dimensions for various sizes of combines if 1 tablespoonful of grain collected is to indicate 1 bushel per acre lost

Rated width of cut	Inside dimensions of sampling pan, inches	
	Length*	Width*
40 inches	40	66
42 inches	42	63
4 feet	48	55
4½ feet	54	49
5 feet	60	44
5½ feet	66	40
6 feet	72	36
7 feet	72	31
8 feet (Double-width pans; 1 tablespoonful = ½ bushel per acre)	60	55
9 feet (Double-width pans; 1 tablespoonful = ½ bushel per acre)	60	49
10 feet (Double-width pans; 1 tablespoonful = ½ bushel per acre)	60	44
12 feet (Double-width pans; 1 tablespoonful = ½ bushel per acre)	60	36
16 feet (Double-width pans; 1 tablespoonful = ½ bushel per acre)	60	27

*Length refers to the dimension of the pan which is placed across the direction of travel; width represents the distance traveled while the sample is collected.

With combines cutting more than 7 feet, it is desirable to use a double-width pan to get a larger sample but keep in mind that 1 tablespoonful in the measuring glass then represents a loss of only ½ bushel per acre.

Primary requirements of the sampling pan are that it be light so that it can easily be thrown under the back of the combine, and that it be grain tight and reasonably sturdy. One satisfactory design which utilizes nonstrategic materials consists of 1-inch by 3-inch wood sides and a canvas bottom secured by wood batten strips. The sides should be reinforced by nailing 2-inch by 8-inch sheet steel straps around the outside of the corners. Another design utilizes ¼-inch plywood for the bottom in place of canvas. A sheet steel bottom was tried, but this type must be fastened with screws at close intervals if it is to stay grain tight. A complete sheet steel pan might be good but would be more difficult to fabricate.

RESULTS

The principal question arising with this method was whether a sample of this small size would indicate loss accurately enough to be of practical value to the farmer. With this method, variations from the true average loss can be caused by: yield and condition of the crop at the spot where sampled varying from the average; irregular flow of straw through the combine making it difficult to catch an average sample of straw; no collection of the unthreshed grain in the heads.

During the 1942 tests of combine efficiency conducted by the Department of Agricultural Engineering, this new method was checked against the regular technical test in which all straw and chaff were collected for 1/100 of an acre, rethreshed, and measured for losses.

For the simplified test, a measuring cylinder of 1 inch inside diameter was used; every ⅝ inch of depth corresponded to a loss of 1 bushel per acre. The 6-foot combine used required a sampling pan 6 feet long and 20 inches wide to be placed across the direction of travel. Results of 14 tests in wheat yielding from 30 to 50 bushels per acre are shown in table 2.

Since a tablespoonful is almost twice as large as the volume measure

TABLE 2.—Comparison of combine losses as measured by regular 1/100-acre test and by simplified test

Test No	Combine losses in bushels	
	Regular test	Simplified test
62	1.00	0.9
63	.65	.4
64	.76	.8
66	.76	.6
67	1.05	1.2
101	1.46	1.6
102	1.22	2.4
103	1.36	4.3
104	.54	.4
107	.71	.9
108	1.70	1.5
109	.70	.9
110	1.36	1.0
111	1.91	4.0

Average variation 0.58 bushel per acre
Average variation where losses by regular test were than 1 bushel per acre .16 bushel per acre

used for the tests reported in table 2, the pans for farm use are correspondingly larger. This larger size should increase the accuracy of the test.

It will be noted in table 2 that the results of the simplified test were most reliable when losses were less than 1 bushel per acre. In general, losses exceeding this figure were caused by overloading the machine, and when overloading occurred, straw did not flow evenly over the rack but tended to bunch, thus reducing the chances of catching an average sample of straw. From a practical standpoint, this should not be a serious fault, because if a loss of more than 1 bushel per acre is indicated, the operator will usually adjust his machine until he is under this figure and in the range where the simplified test is reasonably accurate.

With combines through which straw normally flows in bunches, the operator will have to take an average of several tests for a reliable reading. The chaff usually comes out evenly in any machine, and the shoe loss should run fairly constant.

That the unthreshed grain in the heads is not collected is ordinarily inconsequential because of the very small amount lost in this way. Most farmers have a tendency to overthresh, and they can readily detect underthreshing by inspecting the threshed heads.

Results indicate that variation in the crop is not a serious source of error. Appearance of the crop is a good guide, and it is up to the operator to select a representative spot for taking the sample, one where the crop is in average condition for the field.

The full rated cut should be taken, and the combine should be up to speed while the sample is collected.

If a straw spreader is being used, it must be removed for the test.

Winnowing is most easily done by pouring the collected chaff and grain from one container into another in a breeze. Ordinary wash basins or kitchen pans can be used for this operation. If there is no breeze, the fan blast of the tractor can serve as a substitute.

Results secured with this new simple test should be reasonably accurate, especially if several checks are made. At least, an excessive loss will be detected, and the operator can change his adjustments until the loss is reduced.

RELATIONSHIP BETWEEN NUMBER OF FRUITING BRANCHES AND YIELD OF APPLES PER TREE

C. W. ELLENWOOD

During the growing seasons of 1941 and 1942, some observations were made at the Experiment Station on the relationship between the number of fruiting branches on Stayman Winesap and Delicious and the yield per tree. This type of information may be helpful in anticipating possible yields per tree or per acre from vigorous Delicious and Stayman Winesap trees 20 to 30 years old, the age of the trees observed.

There were 17 Stayman Winesap and 23 Delicious trees in the group. The trees had been set in 1915 and were apparently all in good vigor and of nearly equal height and diameter. All fruiting branches between ½ and 1 inch in diameter were included in the count taken March 16, 1942, after a light pruning had been given all the trees. The yield records are for the years of 1941 and 1942 and, therefore, embrace a 2-year yield cycle.

In table 1 it will be noted that the yield per branch on the Stayman Winesap was remarkably uniform regardless of the total number of fruiting branches on the tree. However, this uniformity was not so pronounced on Delicious. The Delicious trees in the group having an average of 199 fruiting branches per tree had an average yield per branch of 2.6 pounds, while the trees in the two groups having greater numbers of branches per tree had yields of 1.8 and 2.0 pounds per branch.

On the 23 Delicious trees as a whole, the average annual yield per fruiting branch for the 2-year period was slightly more than 2 pounds. For the Stayman Winesap trees, the average annual yield was 2.5 pounds per branch.

It is not known whether these relationships would apply to younger trees or to other varieties.

TABLE 1.—Relationship between number of fruiting branches and yield per tree of Delicious and Stayman Winesap apples

2-year period, 1941-1942

	Delicious	Stayman Winesap
Total number of trees under observation	23	17
150 to 225 branches per tree		
Number of trees in group	4	4
Average number of fruiting branches per tree	199	198
Average annual yield per tree, pounds	509	522
Average annual yield per branch, pounds	2.6	2.6
225 to 275 branches per tree		
Number of trees in group	8	7
Average number of fruiting branches per tree	254	245
Average annual yield per tree, pounds	445	605
Average annual yield per branch, pounds	1.8	2.5
275 or more branches per tree		
Number of trees in group	11	6
Average number of fruiting branches per tree	316	304
Average annual yield per tree, pounds	625	715
Average annual yield per branch, pounds	2.0	2.4

BUCK RAKE PERFORMANCE IN HAULING HAY AND GRAIN BUNDLES

C. B. RICHEY

During the summer of 1942, some time studies were made to evaluate the performance of power buck rakes. As a result of these studies, some factors affecting buck rake performance became apparent, and the studies provided data on the effect of length of haul on time.

Operations involved in bringing hay to the barn with a buck rake, together with the factors affecting the time required for each operation, are:

- Driving from the barn to the hay. Time required depends on:
  - Distance
  - Average speed as affected by—
    - Smoothness and straightness of route
    - Speed of power unit (auto, tractor, or truck)
- Loading the hay. Time required depends on:
  - Size of load
  - Size of windrow
  - Loading speed of power unit
  - Ease with which hay slides back and piles up as affected by—
    - Dryness and type of hay
    - Design of rake
  - Loading techniques
    - Single-loading
    - Double-loading by piling one bunch on top of another and then picking up both
    - Double-loading by bucking one bunch head-on into another
  - Type of lift—hand or power
- Driving to the barn with the load. Time required depends on:
  - Distance
  - Average speed as affected by—
    - Smoothness and straightness of route
    - Speed of power unit
    - Visibility if hay is carried in front of driver
    - Permissible speed for load on tires
- Unloading. Time required depends on:
  - Accessibility of unloading place (inside barn or outside at end)
  - Design of rake

Since so many variables are involved and the operator's skill is extremely variable also, averages are almost meaningless.

The studies were made on first-cutting timothy and clover handled by a rear-mounted auto buck rake equipped with a power lift. The auto was a 1934 eight-cylinder model of medium weight. The rake was 10 feet wide with teeth 12 feet long (10½ feet of effective length). Double-loading was done by piling one bunch on top of another. The loads averaged about 700 pounds. Fuel consumption was about 1 gallon per hour. The hay was fairly heavy and in good condition.

A sample detailed time study for the loading operation was as follows:

Operation	Minutes
Buck first bunch	0.6
Move empty	.4
Buck second bunch	.6
Lift second bunch and lay on top of first bunch	1.0
Pick up double bunch from opposite side	1.0
Clean off loose hay and pitch on with a fork	1.0
Total loading time	4.6

The time for unloading, when the hay was dropped in the barn driveway, including backing in, was 1 minute.

By using the times determined for loading and unloading, it is possible to calculate the time for various lengths of haul if speed is known. Table 1 is calculated for somewhat rough conditions and is based on a speed of 5 miles per hour for the first ¼ mile and 10 miles per hour thereafter. It is assumed that if the haul is longer than ¼ mile, the remaining portion will be on a lane or road which is smoother than the field. Table 2 is based on smoother conditions which allow a speed of 8 miles per hour for the first ¼ mile and 15 miles per hour thereafter. In calculating tons per hour, it is assumed that there will be 15 per cent lost time. In calculating man-hours per ton, a three-man crew is assumed, one on the buck rake, one hoisting the hay into the barn, and one in the mow.

TABLE 1.—Performance of buck rake hauling timothy-clover hay under rough conditions

(5 miles per hour for first ¼ mile; 10 miles per hour thereafter)

	Length of haul in miles				
	⅛	¼	½	1	2
Drive to hay, minutes	1.50	3.00	4.50	7.50	13.50
Double-loading, minutes	4.60	4.60	4.60	4.60	4.60
Drive to barn, minutes	1.50	3.00	4.50	7.50	13.50
Unloading, minutes	1.00	1.00	1.00	1.00	1.00
Total time per load, minutes	8.60	11.60	14.60	20.60	32.60
Tons per hour*	2.1	1.5	1.2	.9	.6
Man-hours per ton†	1.5	2.0	2.5	2.3	3.6

*Assuming 700-pound loads and 15 per cent lost time.
†Two men at barn for ⅛-, ¼-, and ½-mile hauls; one man at barn for 1- and 2-mile hauls.

There are very few data available on the actual weight of buck rake loads, because the farmer putting up hay either has no scales or is too busy to take the weight. Many farmers estimate that they haul 1,000-pound loads, but few have weighed them. Loads of alfalfa weigh more than similar loads of timothy-clover, because alfalfa packs tighter.

In many cases, tons per hour may exceed the figures shown in tables 1 and 2 and the average of 1.9 tons per hour for an average haul of ¼ mile reported in Ohio Agricultural Experiment Station Bulletin 636.

TABLE 2.—Performance of buck rake hauling timothy-clover hay under smooth conditions

(8 miles per hour for first ¼ mile; 15 miles per hour thereafter)

	Length of haul in miles				
	⅛	¼	½	1	2
Drive to hay, minutes	0.94	1.87	2.87	4.87	8.87
Double-loading, minutes	4.60	4.60	4.60	4.60	4.60
Drive to barn, minutes	.94	1.87	2.87	4.87	8.87
Unloading, minutes	1.00	1.00	1.00	1.00	1.00
Total time per load, minutes	7.48	9.34	11.34	15.34	23.34
Tons per hour*	2.4	1.9	1.6	1.2	.8
Man-hours per ton†	1.3	1.6	1.9	2.6	2.5

*Assuming 700-pound loads and 15 per cent lost time.
†Two men at barn for ⅛-, ¼-, ½-, and 1-mile hauls; one man at barn for 2-mile haul.

With short hauls, the rate at which hay can be stored in the barn is the limiting factor, rather than the rate at which the buck rake can bring in hay.

Time studies were also made of buck rakes hauling grain bundles to threshers. In order to prevent shattering of the grain, it seemed to be best to buck at a slow speed as many shocks as would stand up on the rake and then pitch on enough more to make a load. With shocks consisting of about nine 7-pound bundles, six shocks were usually bucked and eight pitched, making a load of approximately 900 pounds. When the field was close to the thresher, it was more efficient not to pitch any and to take in only the bucked load.

Except for the loading operation, the variables involved are the same as those listed for hay. The factors affecting loading time are as follows:

Size of load
Size of bundles
Size of shocks
Distribution of shocks
Amount pitched
Use of extra pitchers in field
Type of rake lift—hand or power

The time studies were made on the same auto buck rake timed on hay and on another one which was very similar. Grain bundles are more compact than hay, and a heavier load of them can be carried. A sample detailed time study of the loading operation when an extra man in the field helped with the pitching was as follows:

Operation	Minutes
Buck six shocks	1.50
Pitch two shocks (driver and pitcher)	.75
Move	.60
Pitch two shocks (driver and pitcher)	.75
Move	.60
Pitch two shocks (driver and pitcher)	.75
Move	.60
Pitch two shocks (driver and pitcher)	.75
Total loading time	6.30

The time for unloading at the threshing machine averaged about 0.70 minute.

By using the times determined for the loading and unloading operations, it is possible to calculate the time for various lengths of haul if the speed is known. Table 3 shows the times for various lengths of haul under rough conditions; table 4, for smooth conditions. In calculating bushels per hour of wheat, it is assumed that 50 per cent of the bundle weight will be grain, a common figure. In calculating man-hours per 100 bushels into the thresher, a five-man crew consisting of one field pitcher, two buck rake operators, and two feeders at the thresher was assumed, except for the 2-mile haul, on which only one feeder, with no field pitcher, was used.

TABLE 3.—Performance of buck rake hauling wheat bundles to thresher under rough conditions

(5 miles per hour for first ¼ mile; 10 miles per hour thereafter)

	Length of haul in miles				
	⅛	¼	½	1	2
Drive to shocks, minutes	1.50	3.00	4.50	7.50	13.50
Loading, minutes	6.30	6.30	6.30	9.30	9.30
Drive to thresher, minutes	1.50	3.00	4.50	7.50	13.50
Unloading, minutes	.70	.70	.70	.70	.70
Total time per load, minutes	10.00	13.00	16.00	25.00	38.00
Tons per hour with two buck rakes*	4.6	3.5	2.8	1.8	1.2
Bushels per hour with two buck rakes†	76	59	48	31	20
Man-hours per 100 bushels into thresher‡	6.6	8.5	10.4	9.7	15.0

*Assuming 900-pound loads and 15 per cent lost time.
†Assuming 50 per cent of bundle weight to be grain weighing 60 pounds per bushel.
‡Assuming a five-man crew consisting of one field pitcher, two buck rake operators, and two feeders at thresher, except for the 1- and 2-mile hauls, in which the field pitcher and one feeder were eliminated.

TABLE 4.—Performance of buck rake hauling wheat bundles to thresher under smooth conditions

(8 miles per hour for first ¼ mile; 15 miles per hour thereafter)

	Length of haul in miles				
	⅛	¼	½	1	2
Drive to shocks, minutes	0.94	1.87	2.87	4.87	8.87
Loading, minutes	6.30	6.30	6.30	6.30	9.30
Drive to thresher, minutes	.94	1.87	2.87	4.87	8.87
Unloading, minutes	.70	.70	.70	.70	.70
Total time per load, minutes	8.88	10.74	12.74	16.74	27.74
Tons per hour with two buck rakes*	5.2	4.3	3.6	2.7	1.6
Bushels per hour with two buck rakes†	86	71	60	46	27
Man-hours per 100 bushels into thresher‡	5.8	7.0	8.3	10.8	11.1

*Assuming 900-pound loads and 15 per cent lost time.
†Assuming 50 per cent of bundle weight to be grain weighing 60 pounds per bushel.
‡Assuming a five-man crew consisting of one field pitcher, two buck rake operators, and two feeders at the thresher except for the 2-mile haul, in which the field pitcher and one feeder were eliminated

Since there are no data available for a direct comparison with hauling bundles by team and wagon, a few time studies were made to secure some. These studies, although fragmentary because made late in the season, indicated that it took about 30 minutes to put on a 2,000-pound

load in the field and 20 minutes to feed it into the thresher. By using these figures, it is possible to calculate the time for various lengths of hauls if the speed is known. Table 5 is based upon a speed of 3 miles per hour.

TABLE 5.—Performance of team and wagon hauling wheat bundles to thresher

(3 miles per hour)

	Length of haul in miles				
	1/8	1/4	1/2	1	2
Drive to shocks, minutes	2.50	5.00	10.00	20.00	40.00
Loading, minutes	30.00	30.00	30.00	30.00	30.00
Drive to thresher, minutes	2.50	5.00	10.00	20.00	40.00
Pitch into thresher, minutes	20.00	20.00	20.00	20.00	20.00
Total time per load, minutes	55.00	60.00	70.00	90.00	130.00
Tons per hour with six wagons*	5.6	5.1	4.4	3.4	2.3
Bushels per hour with six wagons†	93	85	73	57	39
Man-hours per 100 bushels into thresher‡	9.7	10.6	12.3	14.0	20.5

*Assuming 2,000-pound loads and 15 per cent lost time.
†Assuming 50 per cent of bundle weight to be grain weighing 60 pounds per bushel.
‡Assuming three pitchers in field for 1/8-, 1/4-, and 1/2-mile hauls and two for 1- and 2-mile hauls.

The figures on team and wagon hauling indicate that the labor requirements for bringing in the bundles and feeding them into the thresher can be reduced about one-third by using buck rakes instead of teams and wagons. They indicate that one buck rake will replace 2½ to 3 wagons, depending on the length of haul. These figures check closely with reports from the field. Another advantage is that buck rakes can be operated by youngsters capable of driving a car or tractor, since there is little heavy work. On the other hand, the feeders at the thresher have a harder job than anyone in the team-and-wagon setup, unless the thresher is fitted with a low extension feeder which reduces the height to which the bundles must be lifted.

In the Wheat Belt, it is common practice when using team and wagon, for each driver to do his own loading, thus eliminating the field pitchers. The bundles are pitched into basket-type racks, and the loads hauled are somewhat smaller than when the bundles are laid in place by a man on the rack. A time study analysis indicates that if two-thirds of the ordinary load were put on by this method, the labor requirements would be reduced by one-fourth. In other words, five men with basket-type racks could put more bundles into a thresher than four men with ordinary racks, plus two field pitchers. The bundles can be pitched onto the rack in the field just as rapidly as when there is a man loading. Pitching into the machine is somewhat slower, because the bundles are not laid in place, but is faster than pitching from a bucked bunch on the ground. The advantages of the buck rake are considerably reduced when compared with this method of utilizing teams and wagons.

Buck rakes are being used for hauling corn shocks to the husker-shredder. Two to four shocks, depending on their size, can be hauled per load. Feeding the bundles into the husker-shredder is more arduous, however, because they must be lifted

from the ground instead of from a wagon. Some farmers use an extra man on an auxiliary platform, halfway up, and others use a pitchfork.

No time studies were made of hauling corn shocks, but observations indicate that the loading time is less than for hay or grain, since no hand loading is required and the loading distance is short. The teeth must be lifted between shocks so that they will not be broken by the corn stubble, and a power lift for doing this quickly is a great advantage The time for transporting and unloading should not differ materially from that for hay and grain. Reports from the field indicate that one buck rake will keep most husker-shredders busy.

CLIMATOLOGICAL SURVEY FOR OHIO AND WOOSTER, 1942

J. T. McCLURE

The climate at the Ohio Agricultural Experiment Station, Wooster, for the year 1942 was about normal in all respects except rainfall, which was 7.75 inches, or about 22 per cent, below normal. Less than the usual amount of rain fell in 8 of the 12 months; one of these was August, during which precipitation was 2.28 inches below normal. In the State as a whole, the total for the year was only ½ inch below the average.

Precipitation in measurable amounts was recorded on 111 days. During the year, 127 days were recorded as cloudy, 95 as partly cloudy, and 143 as clear.

Only 17 inches of snow fell during the year, considerably less than the 50-year average of approximately 29 inches.

The mean daily temperature for the year was normal. The warmest day, 94 degrees, occurred in July; the coldest, 11 degrees below zero, in January. The 55-year records of the Ohio Station show that there is a chance for 13 daily temperature marks to be broken during a year; only 6 were broken in 1942. Nine times the thermometer registered zero or below, raising the total number of such readings to 320 in the last 49 years at Wooster. Six of these have occurred in March; 60, in December; 131, in February; 122, in January; and 1, in November.

The growing season was about normal, including 157 days between April 20 and September 25, dates of the first and last killing frosts.

At the present time, the Ohio Agricultural Experiment Station is cooperating with the Muskingum Conservancy District and the United States Army Engineers in their flood control program and with the United States Weather Bureau in the accumulation of weather data. The Station is not equipped to make weather forecasts.

Climatological summary for Ohio* and Wooster

Month	Temperature, degrees F.								Precipitation, in.			Number of days—				
	Monthly mean	Departure from normal†	Highest °F.	Highest Date	Lowest °F.	Lowest Date	Range	Greatest daily range	Average‡	Departure from normal	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy	Prevailing wind
January	26.3	−1.2	52	1§	−11	8	63	32	1.35	−1.75	2.8	6	7	9	15	SW
February	24.4	−3.2	46	16	− 2	3	48	25	2.43	.02	3.0	10	12	3	13	NW
March	39.0	1.5	66	16	22	4	44	33	2.46	− .96	2.8	8	8	9	14	SW
April	50.8	2.5	87	30	29	1	58	46	2.11	− .91	.5	7	16	2	12	SW
May	60.1	1.4	89	1	36	10	53	35	3.73	.04	0	12	15	5	11	SW
June	68.0	.3	88	11§	46	24	42	35	3.33	− .64	0	11	15	7	8	S
July	71.5	− .3	94	18	50	2§	44	35	2.12	−1.89	0	10	20	5	6	SW
August	70.3	.5	86	14§	42	26	44	37	1.32	−2.28	0	7	18	10	3	SW
September	61.5	−2.4	89	14	27	28§	62	36	3.40	+ .22	0	9	14	13	3	S
October	53.0	1.1	79	2§	24	27§	55	40	2.23	− .29	0	9	13	10	8	SW
November	41.0	.6	70	20	21	27	49	29	2.52	− .11	2.0	9	5	9	16	SW
December	25.5	−5.1	52	27§	− 8	21	60	31	3.42	.80	6.25	13	0	13	18	SW
Annual	49.3	− .3	94	July 18	− 8	Dec. 21	102	46	30.42	−7.75	17.35	111	143	95	127	SW
Ohio, 1942																
January	28.5	.1	65	18	−21	6§	86	....	1.48	−1.57	3.6	7	10	7	14	....
February	26.9	−2.4	60	6	− 7	3	67	....	2.66	.05	4.9	11	8	6	14	....
March	42.2	3.4	83	16	12	4	71	....	3.30	− .08	4.8	13	9	7	15	....
April	54.5	4.6	96	30	21	13	75	....	2.70	− .47	.2	7	16	7	7	....
May	62.5	1.9	95	1	30	5§	65	....	3.96	.30	T	13	9	11	11	....
June	71.2	1.6	95	2§	41	18	54	....	4.19	.28	0	11	10	13	7	....
July	74.7	1.0	102	18	43	7	59	....	3.98	.17	0	11	14	12	5	....
August	71.3	− .4	98	2	35	25	63	....	3.48	.08	0	10	11	13	7	....
September	64.6	−1.1	94	14§	24	29	70	....	3.18	.24	T	10	13	10	7	....
October	55.3	1.7	86	3§	17	27	69	....	2.03	− .52	T	10	13	6	12	....
November	43.6	2.1	78	20	11	15	67	....	3.72	1.01	2.4	12	7	8	15	....
December	27.8	−4.0	68	27	−17	21	85	....	3.75	1.01	9.7	15	5	5	21	....
Annual	51.9	.7	102	July 18	−21	Jan. 6§	123	....	38.43	.50	25.6	130	125	105	135	....

*Data for Ohio furnished by Geo. W. Mindling, Senior Meteorologist, U. S. Weather Bureau, Columbus, O.
†Years of record for Wooster, 55.
‡Totals given for Wooster.
§And other dates also.

WHAT'S A VEGETABLE; WHAT'S A FRUIT?

J. H. GOURLEY

Interest never seems to wane in the popular question: "What is a fruit, and what is a vegetable?" There are lawsuits over the matter; people are fined for selling "vegetables" on Sunday when they claimed they were selling fruits; radio quizmasters lash out at those who miss the question—and so the matter will not down.

The dictionary cites courts as holding "that all those [products] which, like potatoes, cabbage, carrots, peas, celery, lettuce, tomatoes, etc., are eaten (whether cooked or raw) during the principal part of a meal are to be regarded as *vegetables*, while those used only for dessert are *fruits*." Then an apple eaten during the meal would be a vegetable, but one eaten for dessert would be a fruit!

It is not a great stretch from the word "vegetative" to "vegetable", which denotes rather closely the real meaning. Bailey gives a usable definition when he says that a vegetable is the more or less succulent and edible portion of a plant not intimately associated with the flower in its development. This term would cover a root, a stem, a bud, and a leaf or part thereof; for example, a sweet potato (a root), Irish potato or cauliflower (both stems), cabbage and Brussels sprouts (both buds), spinach (a leaf), etc. Peas and lima beans as they appear on the table are neither vegetables nor fruits, although most people think of them as vegetables, but seeds. This term would not include the tomato, which is as truly a fruit as a peach, a watermelon, or an orange.

One of the few stumbling blocks in this classification is sprouting broccoli, which consists mostly of stem, but also of flower buds and, often, opened flowers. This is a transition type.

What, then, is a fruit? In the first place, a fruit is derived from a flower. It represents the enlarged or developed pistil or ovary of the flower. Other parts may be so intimately associated with it as to be "part and parcel" of the fruit. It is by no means necessary that it be edible, for the little berries on poison ivy are as truly fruits as are the berries in a cluster of grapes. Neither is it necessary that the structure be "ripe", as is often indicated, for do we not eat "green" olives, pickles, sweet corn, peppers, okra, and many others? Neither is it necessary that they contain seeds, for we have seedless oranges, grapes, tomatoes, and many others. They always do possess ovules, however, the structure that becomes a seed upon fertilization.

Hence, we can say that a fruit is a developed pistil together with any intimately associated parts. Complicated fruit structures are found in the fig, pineapple, pomegranate, and others.

Now we grant that we do not want such fruits as tomatoes, cucumbers, and peppers in our "fruit" salad but insist that they be served as "vegetables." Actually, however, the distinction in origin of a vegetable, a fruit, a seed, and a flower is all clear cut from a botanical or technical standpoint, and the distinction is relatively simple in most cases.

RELATIVE ABRASION TO SPRAY NOZZLE DISCS BY VARIOUS FUNGICIDAL DUST INGREDIENTS

J. D. WILSON

A large number of different materials are used in dust mixtures applied to plants for the control of diseases and insects (1, 2). Since these include both organic and inorganic compounds that vary greatly in particle size and hardness, it is to be expected that the different materials and mixtures of them would cause different amounts of wear to the machines used in applying them. Certain mixtures have caused serious wear to fans, fan cases, and tubes of large power-driven dusters in a few weeks of operation, whereas similar machines have operated for months with other mixtures. This abrasive action is objectionable in most instances, although certain materials may be desirable in spite of it, for instance, in the preparation of certain rotenone-bearing mixtures (3). Abrasion should be considered in the development of dust mixtures for specific disease-control purposes. For this reason, comparison has been made of the relative abrasiveness of a considerable number of the ingredients commonly used in these mixtures.

It was not practical to compare the large number of materials tested by actually measuring the rate of wear on duster parts. Instead, the different ingredients were compared in water suspensions, spray mixtures prepared by mixing the test materials with water. The spray "mixtures" were prepared by adding a given ingredient to water at the rate of 10 pounds in 100 gallons. These suspensions were then forced through the discs of sprayer nozzles under selected pressures, usually 400 pounds, for certain time periods. A sprayer of the greenhouse type[1] and a large cooling coil were used. Good agitation, necessary in any sprayer to be used for this type of experiment, was provided by special design.

The amount or rapidity of wear was measured as the increase in the original rate of flow of water through the disc after a certain period of operation (4). The ranking of the different materials as obtained by this method is not, of course, exactly comparable to what would have been obtained by measuring the rate of wear of dry materials on dry metal. There is good reason to believe, however, that most of the materials that are highly abrasive to the spray disc have a similar action and ranking by the dry method and that others would rank as mildly abrasive by both methods. There are a number of materials, such as gypsum and bentonite, that can be expected to behave quite differently under the wet and dry conditions, however.

1. Wilson, J. D. 1935. New treatments for cucumbers. Ohio Agr. Exp. Sta. Bimo. Bull. 20: 68-75.

2. Wilson, J. D., and Frank Irons. 1942. Specifications of some of the ingredients commonly used in dust mixtures. Ohio Agr. Exp. Sta. Bimo. Bull. 27: 26-41.

3. Wilson, F. H., and R. L. Jones. 1942. Carriers of rotenone dusts. Soap and sanitary chemicals 18: (April) 103 and 105.

4. French, O. C. 1936. Rate of wear of spray-gun disks. Agr. Engin. 17: 67 and 88.

[1]The sprayer and coil were furnished by the F. E. Myers & Bro. Co., Ashland, Ohio.

Spray discs of any material are worn chiefly by corrosion, erosion, and cavitation (4, 5, 6). Diffenbach (5) found that brass, which contains much copper, is fairly resistant to the corrosive action of Bordeaux mixture, and that pure copper is fully resistant. Stainless steel is also fully resistant, but ordinary steel, of which many spray discs have been made, is very susceptible. Corrosion played but a small part in wearing the discs used in these tests because of the short time periods involved (never more than 10 hours) and the inert nature of most of the materials tested. Cavitation, as described by Turner (6), probably played a somewhat greater part in wearing the discs. Most of the wear was a result of the abrasive action (erosion) (4, 6) on the metal of the discs by the individual particles of the materials in water suspension as they were making their escape through the orifice of the spray disc.

According to Turner (6) at least nine factors play a part in determining the rate of disc (orifice) wear. They are: type and concentration of material used in the spray formula, type and amount of foreign material present (in these tests any foreign matter was considered to be an integral part of the material being tested but would be represented by sand and soil particles in many spray mixtures), pressure used, size of the orifice in the disc, thickness of the disc, whether the orifice was drilled or punched in the material of the disc, composition of the disc metal, how it had been treated (hardened, tempered, etc.), and variations in nozzle construction.

Most of the discs used in these tests were of brass, and the orifices (drilled) were 4/64 (No. 4) inch in diameter. The material was 1/32 inch thick and had not been treated to affect its hardness or toughness in any way. The material of these brass discs had a Brinell hardness of 121, a Rockwell hardness of 96 on the "F" scale, and a Monotron value of 12. In contrast, the steel discs used in a few comparative tests had a Brinell hardness of 400, a Rockwell hardness of 43 on the "C" scale, and a Monotron value of 50. The use of brass discs gave a different (particular) set of values to the data obtained than would have been obtained with discs of steel or any special alloys, but since the brass was susceptible of rapid wear, it made possible the use of comparatively short test periods and still provided maximum differences between the abrasion values obtained for the different materials (dust ingredients) tested.

The nozzle was of the Fembron type with a two-holed whirlplate. The whirlplate was of steel and in these tests was separated from the spray disc by a lead washer 5/64 inch thick. Lead was substituted for leather in these tests to provide a greater constancy of thickness throughout a series of disc changes.

On the whirlplates used in these nozzles, a small area of the metal directly beneath the orifice in the spray disc disintegrated rapidly during the test period when some of the most highly abrasive materials were being used. This wearing action seemed to be a combination of cavitation and abrasion (6), since whole

5. Diffenbach, E. M. 1937. Corrosion tests of metal and alloys in spray mixtures. Agr. Engin. 18: 301-302.

6. Turner, C. N. 1940. A study of the problem of erosive wear and cavitation in the orifice of nozzle discs as applied to Bordeaux mixture. Ohio State Univ. M. S. thesis.

irregular bits of metal were apparently removed from the material of the plate. After this pitting first became noticeable, a hole clear through the whirlplate quickly resulted, and any test in progress had to be abandoned. To avoid this possibility, new whirlplates were used whenever tests with highly abrasive materials were to be made. Because of the rapid wear on the pump, relief valve, and particularly the spray disc by some of these materials, the comparative tests reported in table 1 were made with an operational period of only 30 minutes. A few tests with some of the more mildly abrasive materials were made with longer intervals of sprayer operation.

A standard procedure was followed in making each of the 30-minute tests used in collecting the data on abrasion that are given in table 1. The sprayer tank was filled with water, and the average delivery rate of the pair of discs to be used in a test was determined. Irregularities on the rim of the orifice in the spray disc were carefully removed on a fine stone before the discs were calibrated, since these rough edges or burrs, resulting from the drilling operation, affect the rate at which water will pass through such an orifice (4, 6). Delivery rates were determined by placing each nozzle of the spray gun in a separate 10-gallon can equipped with a tightly fitting cover in which a hole slightly larger than the outside diameter of the nozzle had been made. The two cans were placed close together on a platform balance with the covers arranged in such a way that the two nozzles of the spray gun could be quickly dropped through the holes. The discs were calibrated on the basis of the amount (pounds) of water at 400 pounds pressure that would pass through the orifice of each in 5 minutes (approximately 0.75 gallon per minute in most instances). The sprayer tank, which had a capacity of 50 gallons, was then drained and filled with a mixture of water and the material to be tested. After 30 minutes of operation with this material, a 5-minute test was made with water again in the sprayer tank to determine the rate of water delivery. The percentage increase in the original rate of water delivery after the discs had been subjected to the test material

TABLE 1.—Comparative abrasion of brass spray discs when various ingredients of fungicidal dust mixtures were mixed with water (10 pounds in 100 gallons) and forced through the orifice of the disc at 400 pounds for 30 minutes

Material tested	Percentage of increase in rate of water delivery	Material tested	Percentage of increase in rate of water delivery
Whiting, 325-mesh	48.10	Wisconsin Talc	11.11
Pyrax B	47.68	Bancroft Clay	10.74
Pyrax ABB (pyrophyllite)	46.15	Maryland soapstone	10.70
Ruhm phosphate rock	41.00	Crown Clay	9.30
Georgia Talc, 300-mesh	39.13	Sulfur, 325-mesh	7.84
Tremoline	36.20	Celite	7.14
EMTCO 25 Talc	32.30	Calcium arsenate	6.94
Loomkill Talc	29.03	Whiting, 400-mesh	6.84
Carbola Superfine Talc	18.14	B. F. Gypsum	5.51
EMTCO 23 Talc	17.24	EMTCO 29 Talc	4.82
Minco Clay	16.50	Silene	3.00
Tennessee phosphate rock	16.44	Walnut shell flour	2.92
EMTCO 42 Talc	15.90	Cherokee Clay	2.36
Blue Ridge Talc	14.00	Perry Clay	2.10
Kemidol super-hydrate lime	12.67	Alabaster Gypsum	1.82

for 30 minutes was taken as the measure of comparative abrasion caused by the different ingredients. For instance, if a pair of new discs delivered water at an average rate of 5 pounds per minute and this rate was increased to 7 pounds after 30 minutes of wear, the percentage of increase was 40. The data of table 1 were calculated on this basis.

Most of the materials listed in table 1 have been used in experimental dust mixtures in Ohio, and a considerable number of them have been applied to plants in disease-control studies. Whiting (325-mesh) has been found to be a little too coarse, heavy, and abrasive to use as a diluent for fixed copper dust mixtures, and the collector fines grade (whiting 400-mesh) is now used. Pyrax ABB is the standard grade of Pyrax used as a diluent or carrier in fungicidal and insecticidal dusts. Other grades of Pyrax listed in these tests were used for experimental purposes only. Loomkill Talc is the dusting grade of that material, and Tremoline was included only for the purpose of comparison. Ruhm phosphate rock in a finely ground form has been used as a fixed copper diluent. Of the various grades of EMTCO Talc listed, only No. 23 is generally used in dust mixtures. The others were included as comparison materials in these abrasion tests. A number of the clays listed have been used as diluents. Celite (an infusorial earth) has been used as a bulking agent in dust mixtures because of its low weight per cubic foot of material. The gypsums listed have been tested experimentally in dust mixtures at various times. The Alabaster grade is the most promising of the two and seems to possess an extremely low coefficient of abrasion. The other materials of table 1 were included for test purposes only.

Variations in particle size distribution, which will be discussed later in connection with the data of table 3, are certainly not alone responsible for the different degrees of abrasion exhibited by the materials listed in table 1. The amount and kind of the various silicates, phosphates, carbonates, and the like present in the different materials, and their crystal shape, are undoubtedly additional important factors. Hydrous aluminum silicate, which is a common and often the chief constituent of clays and some soils, has a hardness of 1 to 2.5 on the Mohs scale as used in mineralogy. As shown in table 1, the "clays" were comparatively nonabrasive to the brass spray discs. Talcs, which contain chiefly magnesium silicate in scaly or tabular crystals, have the same relative hardness as the kaolin clays. Most of those listed in table 1 apparently contain as impurities larger proportions of harder materials than the clays tested, since as a group they were more abrasive. Quartz (SiO_2) in one or another of its various forms (such as fine sand) probably occurs as an impurity in some of the diluent materials of table 1. It is very abrasive, with an average hardness of 7 and sharp-cornered crystals. Magnesium or dolomitic limestones (the whiting of table 1), which have a hardness of 3.5 to 4.5 are sometimes very abrasive, especially if they contain still harder impurities. Calcite limestone has a hardness of approximately 3 on the Mohs scale. Gypsum (calcium sulfate) occurs in several varieties with an average hardness of 2 and should not be much more abrasive than many of the clays. It was not in the data of table 1. Phosphate rock (a form of apatite that usually contains from 15 to 40 per cent of P_2O_5) varies in hardness from 2 to 5 and might be expected to be rather abrasive, with

the degree again dependent on the presence of other materials. It did wear the brass discs used in these tests rather rapidly, but this result may have been complicated by the fact that these samples of phosphate rock were not nearly as fine in terms of particle size as were most of the materials listed in table 1.

Many of the dust mixtures now used for the control of plant diseases are prepared by adding one of the diluents listed in table 1 to one of the copper compounds listed in table 2. These compounds all belong to the group known as the "fixed" or "insoluble" coppers, and they are comparatively insoluble in water as rain or dew. They are prepared in very small particle size to ensure their best possible distribution over the surface of leaves and, thus, maximum fungicidal action. Many of the materials of table 1 have a particle size distribution such that at least 90 per cent of the particles are larger than 5 microns, but this condition is reversed for the fixed coppers listed in table 2, for at least 90 per cent of the particles of these fixed coppers are smaller than 5 microns. The extremely fine nature of these copper materials has a tendency to reduce their abrasive effect to a minimum. The increase in the rate of water delivery after 30 minutes of sprayer operation with these copper compounds was no greater in most instances than with any but the least abrasive of the materials listed in table 1. The influence which particle size may play in determining abrasion is illustrated with Basicop and Tribasic. Basicop "special", with an average particle size about half that of Basicop, increased the flow of water after 30 minutes of sprayer operation only about one-fourth as much as did Basicop. Tribasic "special" had a similar relation to Tribasic in both particle size and abrasion.

The influence of particle size on abrasion is further illustrated in the data of table 3. EMTCO 25 Talc is the coarsest grade listed for that material. Numbers 23 and 42 are similar in particle size and abrasive properties. Number 29 is by far the finest talc of these four numbers and has an average particle size and abrasive coefficient only about one-fourth so great as that of EMTCO 25 (2). The coarse, medium, and fine fractions of EMTCO 23 were obtained by fractionating a sample of the original material in an air tunnel, an operation that will be described in a later paper on the subject of fractionation of dusting materials. Most

TABLE 2.—Comparative abrasion of brass spray discs when various fixed coppers were mixed with water (10 pounds in 100 gallons) and forced through the orifice of the disc at 400 pounds for 30 minutes

Material tested	Percentage of increase in rate of water delivery	Material tested	Percentage of increase in rate of water delivery
Brown cupric oxide	12.42	Tribasic	5.00
Cupro-K	10.27	Yellow Cuprocide	3.85
Copper A Compound	9.17	Basicop "special"	2.20
Basicop	8.62	Copper oxychloride	1.93
Coposil	7.00	COC-S	1.85
Red Cuprocide	5.72	Tribasic "special"	1.78
Copper Hydro 40	5.39		

of the largest particles were sorted into the coarse fraction. The abrasion was progressively less with a decrease in average particle size. Pyrax ABB was also fractionated in an air tunnel, and the abrasive actions of the coarse, medium, and fine fractions varied much as they did with EMTCO 23. The fine fraction, which was collected in muslin bags at the end of the tunnel, was of very small particle size and had a very low abrasion coefficient. These relative values for Pyrax ABB and its fine fraction indicate that much of the abrasive action of this material must be due to coarse particles, both of pyrophyllite and of various impurities. The influence on abrasion of making Pyrax ABB finer than usual is indicated by a comparison of this material with Pyrax ABB "special grind." Collector fines whiting, which is saved during the grinding of 325-mesh whiting and has an average particle size less than one-half that of the 325 grade, causes far less abrasion. Apparently most of the abrasion by the 325-mesh material was caused by large particles and various impurities, a result which indicates that the coarse fraction includes most of any hard impurities that may be present.

Certain representative diluent materials that are rather commonly used in preparing fungicidal dust mixtures and which were known to vary considerably in their abrasive action on the metal of dusting machines were selected for a series of 2-hour periods of sprayer operation. The relative increases in the rate of water flow through the spray discs used in this experiment are shown in table 4. Bordeaux mixture prepared with Kemidol Colloidal Hydrate (lime) was included to afford a comparison with the diluent materials and to complete the series of discs shown in figure 1. The different materials included in table 4 showed the same relative abrasion as in table 1.

The appearance of the orifice in some of the brass discs used in these 2-hour tests with a number of different materials is shown in figure 1. The disc in the lower right-hand corner of the figure was subjected to water only, and the edge of the orifice is sharp and even. The next disc to the left showed little visible wear after a clay suspension was forced through it for 2 hours. The capacity of this orifice to deliver water was increased by 5 per cent, and this increase must have resulted from the very slight blunting or

TABLE 3.—Influence of particle size on the abrasive action of various materials

Material tested	Percentage of increase in rate of water delivery	Material tested	Percentage of increase in rate of water delivery
EMTCO 25 Talc	32.30	Pyrax ABB	46.15
EMTCO 23 Talc	17.24	Pyrax ABB, coarse fraction	47.46
EMTCO 42 Talc	15.90	Pyrax ABB, medium fraction	40.53
EMTCO 29 Talc	4.82	Pyrax ABB, fine fraction	6.54
EMTCO 23 Talc, coarse fraction	22.35	Pyrax ABB, "special grind"	31.90
EMTCO 23 Talc, medium fraction	17.08	Whiting, 325-mesh	48.10
EMTCO 23 Talc, fine fraction	12.11	Whiting (collector fines) (400-mesh)	6.84

rounding of the sharp inner edge of the disc orifice (4). The third disc to the left in the bottom row was used for Bordeaux mixture, and this picture illustrates what happens to the inner corners of the orifice as wear begins (9.3 per cent increase in rate of water flow). The corners are rounded, and in the view presented (inner or whirlplate side) the orifice has begun to appear out of round. This condition was not visible from the outer face of the disc. The disc on the lower left corner (used for whiting) and those in the upper row all show definite increases in the original size of the orifice. This increase in orifice diameter became visible in most cases after the delivery capacity of the disc had increased about 10 per cent. French (4) and Turner (6) showed that most of the early increase in delivery rate occurs just as the sharp corners and rough edges of the discs are worn off. After this initial change, the rate of delivery through hardened steel or alloy discs may change but little for a considerable period. French also found brass (a softer material) to wear at a more uniform rate than steel throughout the period during which a disc was used. In the present tests the diameter of the orifice often changed rapidly after the stage represented by the disc in the upper right corner of figure 1 had been reached, but there was not a correspondingly rapid increase in the delivery rate of water or spray material thereafter in these experiments.

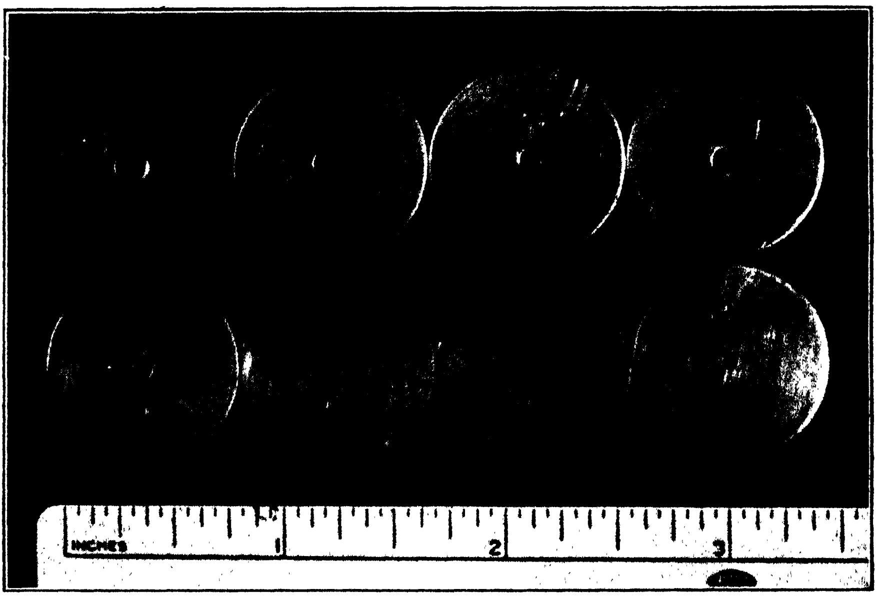

Fig. 1.—Appearance of the orifice in brass spray discs after 2 hours of operation at 400-pound pressure. Beginning at the upper left, the materials in water suspension (10 lb. in 100 gal.) were: Pyrax ABB, Loomkill Talc, EMTCO 23 Talc, B. F. Gypsum, collector fines whiting, Bordeaux mixture (10-10-100), Perry Clay, and water only.

TABLE 4.—Increase in delivery rate of brass spray discs after 2 hours of operation with water suspensions of various materials (10 pounds in 100 gallons)

(Appearance of discs is shown in fig. 1)

Material tested	Percentage of increase in rate of water delivery	Material tested	Percentage of increase in rate of water delivery
Pyrax ABB (pyrophyllite).....	120.80	Whiting (collector fines)....	23.80
Loomkill Talc..................	93.55	Bordeaux (10-10-100)........	9.30
EMTCO 23 Talc...............	45.24	Perry Clay....................	5.60
B. F. Gypsum (dusting)......	28.88	Water only	.30

This progressive change in the rate of disc wear and increase in the rate of water delivery can be shown by averages obtained from some of the data relative to table 1. The average rate of increase in spray material delivery during the first 5 minutes of operation (represents average condition at end of 2½ minutes) for 10 of the most abrasive materials listed in table 1 was 16.4 ounces, or 3.69 per cent of the original capacity. During the period between 10 and 15 minutes (average at 12½ minutes after start) the average rate of increase was 5.4 ounces, or 1.21 per cent. During the last 15 minutes of the test (average at 27½ minutes after start) the rate of increase was 5.0 ounces, or 1.14 per cent. The corresponding averages for the 10 least abrasive materials of table 1 were 6.0 ounces, or 1.29 per cent, during the first 5 minutes of operation, 3.2 ounces, or 0.69 per cent, during the next 10 minutes, and 1.1 ounces, or 0.24 per cent, during the last 15 minutes. This slowing down in the rate of increase in delivery rate occurred even though more material per minute was passing through the orifice of the disc; perhaps some of the forces other than abrasion that are involved in disc wear, such as cavitation, were also decreasing with an increase in orifice size.

French (4) found a brass disc with a Rockwell hardness of B-55 to show an increase in delivery rate of 50 per cent after 21½ hours of operation with a 10-10-100 Bordeaux mixture at 450 pounds pressure, whereas the increase with a steel disc (Rockwell hardness of C-58) was 9 per cent. In a somewhat comparable test in this series of experiments, 325-mesh whiting (10-100) was found to increase the flow rate through the orifice of a brass disc (Rockwell hardness of F-96 or Brinell of 121) by 49 per cent in 30 minutes, and when a steel disc (Rockwell hardness of C-43 or Brinell 404) was substituted, the increase was 21 per cent. These data indicate that hardness is not necessarily a measure of resistance to abrasion; otherwise steel would have worn much more slowly in comparison with brass.

Turner (6) found that an increase in the solid material in a Bordeaux formula or an increase in pump pressure increased the rate of wear on steel discs of various degrees of hardness. In general, the Rockwell hardness of the steel discs used in his tests was a measure of their rate of wear. There were exceptions in some of the special alloys used, however. An extension of the tests performed in the present experiments included a comparison at 300 pounds pressure of

various Bordeaux formulas prepared with different grades and kinds of lime and with variations in the copper sulfate and lime ratios. Some of these data are presented in table 5.

There was little difference in the abrasive qualities of the high-calcium and high-magnesium lime samples used. The high-calcium hydrated lime was slightly less abrasive than the high-magnesium material, but when the two were used in preparing Bordeaux mixture, the spray that contained the high-calcium material was the more abrasive. When a high-magnesium hydrated lime was allowed to carbonate by exposure to the air in a thin layer for about 4 days, the carbonated material was found to be no more abrasive than the hydrate. If the standard 10-10-100 formula was varied to contain 2½ pounds of copper sulfate, the resulting mixture was slightly more abrasive than the standard, as would be expected, since less lime had been taken from the mixture to combine with the copper sulfate. When the lime was reduced to prepare a 10-2½-100 formula, nearly all of it was used to combine with the 10 pounds of copper sulfate used, and the resulting mixture was lowest of the group in abrasiveness.

To show the general relationship between hydrated lime and Bordeaux mixture prepared with it with respect to abrasion, three different hydrated limes were tested alone (10-100) and in Bordeaux formulas (10-10-100) at a pressure of 400 pounds for 30 minutes. The average increase in the rate of water delivery was 14.99 per cent for the limes alone and 10.72 per cent for the Bordeaux mixture prepared from them. Thus, Bordeaux mixture seems to be somewhat less abrasive than the lime with which it is prepared.

SUMMARY

A considerable number of materials that vary widely in their physical and chemical characteristics are used in the preparation of fungicidal dust mixtures. Practically all of these are capable of causing some wear to the fans, fan cases, and nozzle tubes of the dusting machines used to apply them. The abrasiveness of these materials is very different, apparently depending on such variables as particle size, inherent hardness of the source material, and quantity (percentage) of still harder materials that may be present as impurities.

TABLE 5.—Comparative abrasion of different types of hydrated lime and Bordeaux mixture made from them, and also with different copper-lime ratios (sprayer operated for 30 minutes at a pressure of 300 pounds)

Materials and mixtures tested	Percentage of increase in rate of water delivery	Materials and mixtures tested	Percentage of increase in rate of water delivery
High-calcium lime	7.28	Bordeaux mixture with high-magnesium lime (10-2½-100)	3.43
Bordeaux mixture (10-10-100) with high-calcium lime......	5.88	Bordeaux mixture with high-magnesium lime (2½-10-100)	5.55
High-magnesium lime.........	9.20	High-magnesium lime allowed to carbonate in air	7.65
Bordeaux mixture with high-magnesium lime (10-10-100).	4.81		

It was not practical to test the abrasive action of this number of materials by determining the rate at which they would wear duster parts. Instead, the rate of wear on brass spray-nozzle discs by the different materials in water suspension (10 pounds in 100 gallons of water) was used as a measure of relative abrasion. The results obtained were not exactly comparable to the abrasion of dry material on dry metal, but the relative ranking of different materials is roughly similar by the two methods.

The drilled orifice of the brass spray disc (1/32 inch thick) was 4/64 inch in diameter. The brass used had a Brinell hardness of 121 in contrast to a Brinell reading of 404 for a common type of steel disc. A pump pressure of 400 pounds was used in most of the tests. Since the rate of wear of pump and relief valve parts and the brass spray disc was very rapid for some of the most abrasive materials, test periods of only 30 minutes were used in most instances. The rate at which water passed through the spray discs (about 0.75 gallon per minute) was taken as a measure of their original capacity. After they had been subjected to the wearing action of the test material for a given period of time (30 to 120 minutes in most instances) a second determination of the rate of water delivery was made. The percentage of increase over the original rate was taken as the measure of abrasive action.

In the group of diluent or carrier materials tested (about 30 in all) the "talcs" were more abrasive than the "clays." Finely ground phosphate rock was very abrasive, and coarse whiting was much more abrasive than a finer grade. Gypsum was one of the least abrasive of the materials tested. Calcium arsenate and sulfur, sometimes used as supplemental materials, were mildly abrasive.

The fixed coppers as a group were much less abrasive than the materials commonly used to dilute them, probably because of a smaller particle size (90 per cent under 5 microns compared with 90 per cent over 5 microns in most of the diluents) and the absence of any harder impurities in the copper-containing compounds.

Particle size plays a rather important part in determining abrasive action. A coarse grade of EMTCO Talc caused an increase of 32 per cent in the rate of water delivery through a disc orifice, whereas the corresponding increase for a finer grade of the same material was only 5 per cent. A coarse fraction of Pyrax ABB gave a delivery increase of 47 per cent, and this rate was reduced to 6.5 per cent for a finer fraction. A similar decrease in abrasiveness was recorded when a 400-mesh whiting was compared with a coarser 325-mesh grade. This result probably means that the harder impurities are also chiefly in the coarse fractions.

Bordeaux mixture was found to be less abrasive than any of the dust diluents except clay and possibly gypsum. There was little difference in abrasion between a high-calcium and a high-magnesium hydrated lime of comparable fineness. Bordeaux mixture prepared from these lime samples was less abrasive than the lime alone.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

The total cash income to Ohio farmers from farm marketings in 1942 was $575,000,000. This figure represents a 35 per cent increase over 1941. Government payments under the Agricultural Conservation Program for 1942 totaled $29,000,000 in the State.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935–1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	...	101	101	104	100	105	101
1914	99	...	100	101	102	102	105	109
1915	102	...	105	98	103	107	106	112
1916	125	...	124	118	113	113	121	123
1917	172	...	149	175	140	119	182	201
1918	192	...	176	202	175	131	203	243
1919	202	...	202	213	204	135	218	270
1920	225	...	201	211	236	159	212	230
1921	142	...	152	125	164	134	132	134
1922	141	...	149	132	145	124	127	133
1923	147	...	152	142	160	122	134	147
1924	143	...	152	143	165	118	133	150
1925	151	...	156	156	165	110	159	180
1926	146	...	155	145	170	105	155	183
1927	139	...	153	139	173	99	147	171
1928	141	...	155	149	169	96	154	163
1929	139	...	154	146	169	94	151	172
1930	126	...	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	140
1939	113	103	121	93	117	76	95	140
1940	114	117	122	98	116	77	99	146
1941	127	170	131	122	138	80	121	185
1942	144	...	154	157	173	89	157	244
1942								
January	140	192	146	149	153	...	141	201
February	141	199	147	145	...	...	144	183
March	142	208	150	146	...	89	146	208
April	144	210	151	150	167	...	153	230
May	144	216	152	152	...	...	157	241
June	144	222	152	151	176	...	157	232
July	144	230	152	154	179	...	159	237
August	145	233	152	163	...	...	164	248
September	145	237	153	163	...	...	161	268
October	146	249	154	169	193	...	165	290
November	146	258	155	...	...	...	167	293
December	147	267	156	178	...	...	169	297
1943								
January	149	268	158	182	196	...	174	283
February	149	...	160	178	...	...	177	261
March	...	...	...	...	...	97	184	287

*SOURCE: Bureau of Business Research, The Ohio State University.

BIMONTHLY BULLETIN

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OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO, U.S.A.

YOUR AUTHORS

Robison

As animal-source protein concentrates have become scarce, farmers have had to seek other sources of protein to feed their pigs. W. L. Robison, Ohio Agricultural Experiment Station swine specialist, offers valuable information on the comparative worth of the different plant protein concentrates under different feeding conditions.

Gerlaugh

Rogers

How ripe should we harvest our corn for silage and should we put our corn into the silo or into the crib? These are questions livestock men ask the Experiment Station. In this issue, Paul Gerlaugh and H. W. Rogers give livestock men the results of a test comparing returns per acre from feeding immature corn silage, mature corn silage, and corn-and-cob meal to steers.

Already familiar through their writings to Bimonthly Bulletin readers are poultry specialists, D. C. Kennard and V. D. Chamberlin, disease control specialist, J. D. Wilson, and insect control specialist, J. P. Sleesman.

The cover is the fourth of a series by Harry G. Binau, Station photographer.

IN THIS ISSUE

RETURNS PER ACRE IN STEER FEEDING FROM IMMATURE CORN SILAGE, MATURE CORN SILAGE, AND CORN-AND-COB MEAL[1]

PAUL GERLAUGH AND H. W. ROGERS

U. S. 13 corn from a field divided into strips to give uniformity in the corn area fed to three lots of cattle was used in this test. It was harvested with a field harvester and cut into silage length in the field. The immature silage was cut in what would be considered good roasting-ear stage and put into the silo August 12, 13, and 14, 1941. Considerable juice leached out of the silo after filling. The mature silage was put into the silo September 5, 6, and 8. The corn was well dented,though most of the leaves of the corn plant were green. Many farmers would feel that the corn was ready for the shock by the time the filling with the mature silage was completed. A generous layer of sawdust covered the corn silage when filling was finished, so that there was no loss on the top from filling time until the test started. When the weight of corn-and-cob meal fed to the cattle is used as the weight of corn produced from the area, the strips from which the corn was husked and fed to lot 3 as corn-and-cob meal yielded 78.9 bushels of corn per acre.

Yearling steers were purchased at Chicago, October 2, 1941, weighing 650 pounds and costing $10.60 per hundredweight on the market, or $11 per hundredweight in the feed lot at the start of the test. They were grade Shorthorns of good to choice quality. It was hoped that by using 16 steers in lot 1, 15 steers in lot 2, and 12 steers in lot 3, the three lots could be brought to finish their assignment of eating the same area of corn in the form fed to them at about the same date. Lots 1 and 3 finished on the same date, but lot 2 finished nearly 3 weeks earlier than the other two. The test was started October 21, and the ear corn was fed as chopped or broken ear corn rather than as corn-and-cob meal to lot 2 for a few weeks or until it was dry enough to prepare and feed as corn-and-cob meal.

Soybean oil meal (extracted process) was used at the rate of 2 pounds per day per steer after the cattle were put onto a full feed. Five per cent of minerals was added to the soybean oil meal. Legume hay was fed to all three lots in such amounts as the cattle would eat. The corn silage and the corn-and-cob meal were full-fed.

The moisture content of samples of the silage was determined at different times during the feeding period.

When the lot 2 steers finished their silo, which had been filled with the immature corn, their weights were taken, and the lot was put onto a corn-and-cob meal ration until the other two lots had finished. They were appraised as worth 25 cents per hundredweight less than the steers in lots 1 and 3 when their test closed, and this difference in value was used in the returns. When lots 1 and 3 finished their test, all three lots sold for $13.15 per hundredweight. Lots 1 and 3 are figured on this price; lot 2, on the basis of $12.90 per hundredweight.

The test indicates that an acre of corn put into a silo produces many

[1]Results of a test carried on at the Madison County Experiment Farm, of which H. W. Rogers is superintendent

more daily feeds than the same amount put into a crib. The returns per acre of corn and hay fed to the various lots strongly favored the use of a silo, a result which is in keeping with results of several previous tests conducted at the Madison County Experiment Farm.

The corn plant that was put into the silo in the immature stage had not reached its stage of maximum feeding value. The difference in the amount of dry matter per acre of the two silages was about 17 per cent. There was little difference in the amount of dry matter in the form of silage necessary to put a hundred pounds of gain on the steers.

It seems that a good corn for silage to be fed to yearling steers is one that could be counted on as doing well if husked and then put into the silo just before the time it could safely be cut and shocked.

Results of Madison County steer feeding test, 1941-1942

	Lot 1 Mature corn silage	Lot 2 Immature corn silage	Lot 3 Corn-and-cob meal
Number of steers per lot	16	15	12
Average weight, October 21, pounds	662	660	666
Date test closed	June 21	June 2	June 21
Days on test	243	224	243
Average weight at close of test, pounds	1,128	1,059	1,165
Average daily gain, pounds	1.92	1.78	2.06
Average daily ration, pounds:			
Corn silage	47.6	56.0	....
Corn-and-cob meal	....	....	15.0
Supplement	1.9	1.9	1.9
Hay	2.5	2.7	6.1
Feed required per hundredweight of gain, pounds:			
Corn silage	2,484	3,142	....
Corn-and-cob meal	....	....	730
Supplement	99	107	93
Hay	129	153	311
Moisture in silage, per cent	69.1	74.9	....
Yield per acre:			
Corn silage put into silo, tons	98.4	99.9	....
Corn silage fed from silo, tons	92.6	94.0	....
Corn, bushels fed as corn-and-cob meal	....	....	78.8
Hay, tons per acre	1.75	1.75	1.75
Acres of corn fed	7.93	7.93	7.93
Acres of hay fed	2.75	2.62	5.33
Acres of corn and hay fed	10.68	10.55	13.26
Steer days per acre of corn fed	490	424	368
Pounds of gain on steers per acre of corn	940	755	756
Pounds of gain on steers per acre of corn and hay fed	698	567	452
Gross returns per lot	$ 1,179.42	$ 898.76	$ 958.37
Cost of soybean oil meal fed, at $40.00 per ton	$ 147.80	$ 127.46	$ 111.80
Returns from corn and hay	$ 1,031.62	$ 771.30	$ 846.51
Returns per acre from corn and hay	$ 96.59	$ 73.11	$ 63.84

WHY START CHICKS IN SEPTEMBER?

D. C. KENNARD AND V. D. CHAMBERLIN

Starting chicks in September is justified by three good reasons:

1. September is an opportune time to start chickens for broilers to be marketed during December and January, when there is a seasonal scarcity of chickens for meat.

2. Pullets started in September to come into egg production in March are valuable as replacements for spring-hatched pullets which must be removed from flocks or as replacements for hens to be sold from October to February after having served their purpose for fall or winter egg production.

3. September is one of the best months of the year for starting and brooding chickens because of favorable weather and pasturage conditions during the fall months.

September is emphasized as a favorable time for starting chicks not only because of the weather and pasturage conditions, but also because of the availability of hatching eggs, which become scarce in October. Of still greater importance is that growing chickens started in September can have the benefit of pasturage after the first 2 weeks until about the first of December, when they will be sufficiently matured to be housed in winter quarters without artificial heat. It is during the first 10 to 12 weeks that the greatest benefit can be realized from having the chickens on good fall pasturage, and, in addition, there will be a substantial saving in the cost of feeding the birds when they are on pasturage from September to December 1. Of greatest importance, however, in most instances, will be the better quality of pullets raised on good pasturage in comparison with those raised indoors.

SEPTEMBER PULLETS RAISED INDOORS VERSUS THOSE RAISED IN COLONY HOUSES ON RANGE

The September-hatched Leghorn pullets at the Ohio Agricultural Experiment Station during 1941 and 1942 were raised indoors and in colony houses on a bluegrass range. The pullets raised on range with good pasturage both years were superior in quality to those raised indoors. Moreover, the pullets raised indoors received a complete, more expensive feed than those having access to pasturage which received only the simple, less expensive range ration. The comparative results in 1942 from the point of egg production and livability of the pullets raised indoors and on pasturage are given in table 1.

TABLE 1.—September-hatched pullets raised indoors versus those raised in colony houses on a bluegrass range

March 1 to October, 1942

Method of raising pullets	Number of pullets	Egg production, per cent	Loss of pullets, per cent
Indoors	50	36.0	34.0
Bluegrass range	60	59.4	10.0

The pullets on range were 2 weeks younger but started to lay 2 weeks

before those raised indoors. Coccidiosis was largely responsible for the inferiority of the pullets raised indoors; the pullets raised in colony houses on a clean bluegrass range came through without that handicap. Raising pullets in a permanent brooder house with all its conveniences and other advantages involves a much greater liability of inferior pullets, due to coccidiosis, than raising pullets in a portable colony house on a clean range where suitable pasturage is available. Moreover, no so-called "complete ration" for the indoor requirements of chicks and growing pullets is quite equal to good pasturage (and other helpful factors) supplemented with a simple, less expensive range ration. Obviously, the farm poultry raiser who can produce higher quality pullets in colony houses on a clean range with good pasturage available will generally be well repaid for the inconvenience and other disadvantages of raising chickens in colony houses on range.

EGG PRODUCTION OF SEPTEMBER- VERSUS APRIL-HATCHED PULLETS

In table 2 is a comparison of the spring, summer, and fall egg production of the Station's September- and April-hatched pullets in 1941.

The September pullets laid more summer eggs, as would be expected, since they only started to lay in March. The April-hatched pullets laid more November and December eggs, because these were their first months of production, whereas, the September-hatched pullets had been in production since the first of March. Nevertheless, the September pullets made a creditable record from September 1 to December 31. When the price difference for hen and pullet layers' eggs during these 4 months is taken into consideration, the smaller number of larger hen eggs from the September pullets would generally sell for as much or more than the larger number of smaller eggs from the April-hatched pullets just starting to lay.

As summer and fall eggs generally bring good prices, September-hatched pullets deserve favorable consideration for profitable summer and fall egg production. Moreover, when the September pullets go below a profitable rate of egg production in November or December, they can be sold when hens are usually in good demand and replaced by another crop of September pullets ready to be transferred from the range.

SEPTEMBER-HATCHED PULLETS FOR BETTER ECONOMY OF EGG PRODUCTION

Egg production in the past has been too seasonal for good economy. Brooding equipment used once a year lies idle half the time and undergoes undue deterioration from disuse.

TABLE 2.—Percentage egg production of 160 September-hatched versus 200 April-hatched pullets

March 1 to December 31, 1941

Period of year	Percentage of egg production	
	September-hatched pullets	April-hatched pullets
March 1 to May 31	79	75
June 1 to August 31	62	54
September 1 to October 31	48	*
November 1 to December 31	45	51

*Data for April-hatched pullets not available owing to the closing and starting of new experiments during these months.

Pullets housed once a year suffer a flock reduction from culls and deaths of about 50 per cent, which means an average loss of about 25 per cent of the laying facilities. By starting pullets in September, the brooding equipment is used twice a year, and the idle space in the laying house can be reduced one-half by use of these pullets in March for replacement of dead and cull layers removed from the flock since September. From this method can be realized an increase of about 12 per cent in the yearly egg production.

The considerations thus far have been advantages of September-hatched chickens. There are, however, certain disadvantages which should not be overlooked.

HIGHER COST OF CHICKS

Fall hatching eggs are less available and cost more. Moreover, the percentage fertility and hatchability is generally less than in the spring, adding to the cost of fall-hatched chicks.

MORE UNDERSIZED PULLETS AND SMALL EGGS

Fall-hatched pullets tend to be below normal size and may lay more small eggs during the beginning period of egg production. These shortcomings can be largely prevented, however, by feeding and management to avoid too early maturity.

RESPIRATORY COMPLICATIONS

Under adverse conditions, fall-hatched chickens may be more subject to colds, roup, and bronchitis. The adverse conditions may arise in connection with faulty housing (temperature, ventilation, and overcrowding) conditions when the chickens are raised indoors or unfavorable weather and housing conditions (especially overcrowding) when the chickens are raised in colony houses on range. It is of particular importance to avoid undue exposure of fall-hatched chickens to older chickens, which must be regarded as carriers of respiratory complications readily transmissible to younger, more susceptible chickens. In other words, September-hatched pullets should be housed separately when possible. If they must be housed in the same laying house with hens, they should at least be provided a separate pen (even if it is necessary to put in a temporary partition) so that there will be no direct contact with the hens. Under no circumstances should fall-hatched pullets be put into the same pen with hens.

Advantages of September-hatched pullets not previously mentioned should also be taken into consideration.

FALL-HATCHED CHICKS FROM THE BEST OF THE BREEDING FLOCK

The most valued of the breeding flock are those hens that continue to lay during August and the fall months. Hence, the chicks hatched from eggs collected from hens during these months will represent the best of the breeding flock. What is more, September chicks will generally be from hens rather than from pullets.

It has been the experience of the Ohio Agricultural Experiment Station that September-hatched chicks were especially hardy and vigorous, particularly when brooded and raised in colony houses on range. This condition is believed due to the chicks' being from the best of the breeding flock and to the chicks' being brooded and raised on good pasturage during cool fall weather.

LESS COMPETITION WITH OTHER FARM ACTIVITIES

A distinct advantage of having a crop of September-hatched pullets or broilers on many farms is that more time is available to give the necessary care to the growing chickens during the fall and winter months.

Farm poultry raisers will find plenty of good reasons for starting chicks for the growth of pullets or broilers in September 1943, particularly if the birds are brooded and raised in colony houses where good pasturage is available.

Starting pullets in September can be regarded as a special wartime food contribution by farm poultry raisers. By so doing they will be using their brooding equipment twice instead of once a year. Of even greater importance will be their increased egg production through better use of laying facilities when there is a fall crop of pullets to replace the flock reduction of pullet layers between September and March, or to replace hens which have completed their fall or winter egg production and are due to be sold between October and March.

PLANT PROTEIN CONCENTRATES FOR PIGS

W. L. ROBISON

The scarcity of high-protein feeds, particularly those of animal origin, makes data on the worth of different concentrates used as the sole high-protein feed and used in various combinations in rations for pigs of interest. Since, in swine feeding in the corn belt area, soybean oil meal is used to a greater extent than other plant protein concentrates, it is probably of greatest interest.

IN DRY LOT

SOYBEAN OIL MEAL

A summary of 12 comparisons of soybean oil meal and tankage fed with corn and minerals to pigs in dry lot is given in part 1 of table 1. In 2 of the 12 comparisons ground alfalfa was included in the rations. The pigs were carried from approximately 55 to 200 pounds in weight. Soybean oil meal produced gains practically as efficiently, but hardly as rapidly, as tankage. The pigs fed tankage were ready for market 7 days earlier on the average than those fed soybean oil meal.

In later dry lot experiments, ground alfalfa was included in the ration each time, and a mixture of tankage and linseed meal was used as the standard with which other high-protein feeds or mixtures were compared. Part 2 of table 1 summarizes five trials in which soybean oil meal was compared with a mixture of tankage and linseed meal for feeding with corn, ground alfalfa, and minerals to pigs in dry lot.

The pigs fed the soybean oil meal were ready for market 12 days later, on the average, than were those fed the mixture of tankage and linseed meal. They made more efficient gains. At the prices used, their gains were also less costly. A larger percentage of the pigs fed soybean oil meal became unthrifty and were removed from the experimental lots during the course of the experiments. Because more of the pigs have become unthrifty, feeding soybean oil meal as the only protein concentrate to growing and fattening pigs in dry lot under usual conditions has not been encouraged.

In 1942, an experiment was conducted in which a toasted extracted soybean oil meal and some expeller soybean oil meals, made under differ-

TABLE 1.—Soybean oil meal as the only protein concentrate for pigs in dry lot

	Part 1		Part 2	
	Compared with tankage		Compared with tankage and linseed meal	
	Corn Tankage Minerals	Corn Soybean oil meal Minerals	Corn Tankage Linseed meal Ground alfalfa Minerals	Corn Soybean oil meal Ground alfalfa Minerals
Number of comparisons	12	12	5	5
Pigs at start	76	76	59	59
Initial weight per pig, pounds	54.8	54.9	55.3	55.3
Pigs at close	71	70	55†	50
Final weight per pig, pounds	201.2	199.3	212.7	212.1
Average daily gain, pounds	**1.13**	**1.07**	**1.32**	**1.20**
Days to gain 160 pounds	143	150	122	134
Daily feed per pig, pounds:				
Corn	4.11	3.75	4.29	3.62
Tankage	.40	....	.42	....
Linseed meal	....	....	.26	....
Soybean oil meal	....	.50	....	.80
Ground alfalfa	.02*	.02*	.21	.19
Minerals	.04	.10	.08	.10
Total	4.57	4.37	5.25	4.71
Feed per 100 pounds of gain, pounds:				
Corn	365.04	350.85	325.13	300.70
Tankage	35.22	....	31.87	....
Linseed meal	....	....	19.40	....
Soybean oil meal	....	46.30	....	66.67
Ground alfalfa	1.81*	2.20*	15.93	15.64
Minerals	3.72	9.34	5.78	8.61
Total	**405.79**	**408.69**	**398.11**	**391.62**
Cost of feed per 100 pounds of gain	$8.30	$7.85	$8.28	$7.61
Worth of soybean oil meal, with tankage as 100 per cent	......	83.1%	....	81.3%

*Alfalfa was fed in only 2 of the 12 comparisons.
†Three pigs, weighing 674.5 lb., were taken out for a slaughter test.

For the groups as listed, the total pig days were 9,310, 9,697, 6,943, and 6.797, and the total gains 10,483.5, 10,362, 9,158.0, and 8,176.2 pounds, respectively.

As a rule, except when only ground limestone and salt were fed, the minerals consisted of salt, 19.2; ground limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 4 parts.

PRICES USED: Shelled corn, 1.75; rice pearling cone bran, 2.5; tankage, 4.25; fish meal, 4.25; blood meal, 5.5; soybean oil meal, 2.45; cottonseed meal, 2.85; linseed meal, 2.85; ground alfalfa, 1.5; salt, 1.25; pulverized limestone, 0.75; mineral mixture, 2.1; cod-liver oil, 18; grinding corn, 0.1 cent a pound. Pasture, 1 cent per day per pig.

ent conditions of manufacture, were used. The meals were made from the same supply of beans. In order to bring out more clearly any differences in the nutritive values of the meals, the pigs were started on the various rations at an early age. They were 7 to 10 weeks old and averaged 38 pounds in weight when the experiment began. The pigs were confined indoors. The rations consisted of ground yellow corn, soybean oil meal, ground alfalfa, and minerals. Before and after each group averaged 125 pounds in weight, whatever quantities of the soybean oil meals were required to provide rations containing 16.6 and 14.6 per cent of protein, respectively, were fed. The approximate mineral content, including that in the feeds and that added, ranged from 4.3 to 4.6 per cent. Sufficient soybean oil was added to those lower in fat to bring the fat content of each ration up to approximately 3.8 per cent. Ground

alfalfa made up 5, and added minerals, 2 per cent of the rations. After the first 8 weeks, irradiated yeast at the rate of 0.01 pound to 100 pounds of feed was mixed with the rations to supply vitamin D. The rations were obviously deficient in some respect. Instead of the rapidity of the gains continuing to increase until a weight of 200 pounds was reached, as is typical, that of five groups receiving soybean oil meal as the only protein concentrate slowed down before the experiment was concluded. The pigs fattened rather than grew. They also became wrinkly and rough in the skin. Several had a wheezy respiration.

Two groups of similar pigs similarly fed except that they received ½ and 1 pound of tankage for each pound of expeller soybean oil meal, respectively, and that the soybean oil meal fed them was commercial meal purchased from a local dealer, gained rather slowly at first but more rapidly later and otherwise developed normally. A failure of pigs fed soybean oil meal to grow and develop normally had not been encountered in previous experiments, but in them, pigs that were a little older and heavier at the start were used.

LINSEED MEAL

Various protein concentrates had been compared as supplements to corn for pigs in dry lot and on pasture in a number of earlier experiments. Under dry lot conditions, after they had been on feed for some time, some of the pigs fed plant pro-

TABLE 2.—The effect of limestone, of blood meal, and of yeast when fed with corn, linseed meal, and salt or minerals to pigs in dry lot

	1	2	3	4
	Corn Linseed meal Salt	Corn Linseed meal Salt Limestone	Corn Linseed meal **Blood meal** Salt Limestone	Corn Linseed meal **Fermented with yeast** Salt Limestone
Pigs at start	5	5	5	5
Initial weight per pig, pounds	62.6	62.4	62.4	62.5
Pigs at close	5	5	4	5
Final weight per pig, pounds	179.3	196.5	202.5	201.3
Average daily gain, pounds	**.83**	**1.13**	**1.01**	**1.04**
Days to gain 160 pounds	193	142	159	154
Daily feed per pig, pounds:				
Corn	3.09	3.78	3.50	3.33
Linseed meal	.51	.63	.29	.56
Blood meal	....	....	.14	....
Salt or minerals	.02	.10	.09	.09
Total	3.62	4.51	4.03	3.98
Feed per 100 pounds of gain, pounds:				
Corn	370.47	335.20	348.44	319.56
Linseed meal	61.75	55.86	29.04	53.26
Blood meal	....	....	14.52	....
Salt or minerals	2.06	9.31	9.07	8.88
Total	**434.28**	**400.37**	**401.07**	**381.70**
Cost of feed per 100 pounds of gain	$8.64	$8.38	$8.15	$7.51

Water was added to the feeds for lots 1 to 3 just before feeding. Water was added to that for lot 4 a day in advance, and yeast was allowed to develop in it for 24 hours. A yeast cake was added at the start. Thereafter, culture was provided by pouring some of the liquor from one batch of feed into the next. It was necessary to renew the yeast only a few times during the course of the experiment.

For the lots as listed, the pig days were 700, 595, 556, and 665; the total gains were 583.5, 670.5, 559.0, and 694 pounds, respectively.

For prices, see footnote to table 1.

tein concentrates became unthrifty and ceased to gain. Attempts to improve such rations were made. Linseed meal was used as the protein feed. Soybean oil meal then was comparatively new and was much less commonly available than it has been since.

Some of the materials fed with corn and linseed meal were limestone or minerals, yeast, tomato waste (which included the pulp, skin, and seeds), corn germ meal, cod-liver oil, blood meal, tankage, fish meal, clover, alfalfa, and rice pearling cone bran. In a representative experiment, reported in table 2, adding limestone to corn, linseed meal, and salt increased the rapidity of the gains from 0.83 to 1.13 pounds daily a head and lowered the feed per 100 pounds of gain from 434 to 400 pounds.

The other additions were made with minerals included. Corn germ meal and blood meal were each used in only one trial. Neither was helpful in the instance in which it was tried. Pigs fed yeast required less feed per unit of gain but made no faster gains than those without it. In one trial, chopped clover produced faster gains but no greater gains per unit of feed than a similar ration without it. In another it was of no benefit.

Rations of yellow corn, linseed meal, and minerals with tomato waste, cod-liver oil, tankage, fish meal, or rice pearling cone bran added produced more rapid gains and greater gains per unit of feed than similar rations not including one of these materials. Table 3 gives the results of a test in which tankage

TABLE 3.—Feeding tankage with corn and linseed meal, and cod-liver oil with corn, linseed meal, and minerals to pigs in dry lot

	Experiment A, started January 2, 1920		Experiment B, started August 1, 1923	
	Corn Linseed meal	Corn Linseed meal **Tankage**	Corn Linseed meal Minerals	Corn Linseed meal **Cod-liver oil** Minerals
Pigs at start	6	6	6	6
Initial weight per pig, pounds	81.7	81.7	40.0	40.0
Pigs at close	3*	6	6	6
Final weight per pig, pounds	195.0	195.4	191.8	201.0
Average daily gain, pounds	**1.12**	**1.62**	**.70**	**.94**
Days to gain 160 pounds	143	99	229	171
Daily feed per pig, pounds:				
Corn	4.35	5.45	2.77	3.18
Linseed meal	.73	.55	.47	.55
Tankage	....	.18	....	....
Cod-liver oil	....	....	....	.02
Minerals	....	....	.10	.12
Total	5.08	6.18	3.34	3.87
Feed per 100 pounds of gain, pounds:				
Corn	390.26	335.67	395.05	338.66
Linseed meal	65.04	33.57	67.75	58.73
Tankage	....	11.19	....	....
Cod-liver oil	....	....	....	2.06
Minerals	....	....	14.31	12.35
Total	**455.30**	**380.43**	**477.11**	**411.80**
Cost of feed per 100 pounds of gain	$9.07	$7.64	$9.54	$8.57

*Three pigs were removed after 6 weeks and given minerals.

For the lots as listed, the pig days were 427, 420, 1,302, and 700; the total gains were 476.5, 682, 911, and 657 pounds, respectively.

For prices, see footnote to table 1.

was fed with corn and linseed meal and one in which cod-liver oil was fed with corn, linseed meal, and minerals. Pigs having a rather heavy initial weight were used in the experiment in which tankage was fed.

Table 4 summarizes five trials in which rice pearling cone bran was fed with corn, linseed meal, and minerals. Approximately equal quantities of it and of linseed meal were used. The pigs receiving it ate 24 per cent more feed daily a head, were ready for market 54 days earlier, and required 11.7 per cent less feed per unit of gain than those on the same ration without it.

SOYBEAN OIL MEAL WITH TANKAGE

As its production and economic importance have increased, soybean oil meal has received proportionately greater attention than linseed meal in swine feeding operations and investigations.

Part 1 of table 5 reports three comparisons of a mixture of tankage and linseed meal, with a mixture of tankage and soybean oil meal for feeding with corn, ground alfalfa, and minerals to growing and fattening pigs in dry lot. The pigs fed the mixture of tankage and soybean oil meal gained a trifle more slowly and required slightly more feed per unit of gain produced, but at the prices used, they made less costly gains than those fed tankage and linseed meal. Whether linseed or soybean oil meal is preferable in such a mixture depends on the relative prices of the two feeds. According to the results of these trials, soybean oil meal was worth 2.7 per cent more a pound than linseed meal for use in this manner.

RATIO OF SOYBEAN OIL MEAL TO TANKAGE

Part 2 of table 5 summarizes four experiments in which feeding equal

TABLE 4.—Effect of feeding rice pearling cone bran with corn, linseed meal, and minerals to pigs in dry lot

	1	2
	Corn Linseed meal Minerals	Corn **Rice pearling cone bran** Linseed meal Minerals
Number of comparisons	5	5
Pigs at start	27	27
Initial weight per pig, pounds	55.2	55.4
Pigs at close	25	27
Final weight per pig, pounds	193.4	195.2
Average daily gain, pounds	**.86**	**1.21**
Days to gain 160 pounds	187	133
Daily feed per pig, pounds:		
Corn	3.07	3.31
Rice pearling cone bran	....	.58
Tankage or fish meal	....	....
Linseed meal	.51	.56
Minerals	.09	.11
Total	3.67	4.56
Feed per 100 pounds of gain, pounds:		
Corn	357.13	274.43
Rice pearling cone bran	....	47.55
Tankage or fish meal	....	....
Linseed meal	59.82	46.53
Minerals	10.74	9.20
Total	**427.69**	**377.71**
Cost of feed per 100 pounds of gain	$8.54	$7.78

For groups 1 and 2, the pig days were 4,067 and 3,129; the total gains were 3,490.5 and 3,775.0, respectively.
For prices, see footnote to table 1.

TABLE 5.—Soybean oil meal (1) with tankage; (2) in different ratios; and (3) with cottonseed meal for pigs in dry lot

	Part 1		Part 2		Part 3	
	Versus linseed with tankage		In different ratios with tankage		With cottonseed meal	
	Corn, alfalfa, minerals					
	Tankage Linseed meal	Tankage Soybean oil meal	Tankage, 1 Soybean oil meal, 1	Tankage, 1 Soybean oil meal, 2	Tankage Soybean oil meal	Soybean oil meal Cotton-seed meal
Number of comparisons	3	3	4	4	2	2
Pigs at start	42	42	51	51	28	28
Initial weight per pig, pounds	54.0	54.7	50.4	49.7	53.0	52.6
Pigs at close	41	40	46	41	27	26
Final weight per pig, pounds	202.2	207.5	216.4	213.2	216.0	209.3
Average daily gain, pounds	**1.31**	**1.28**	**1.30**	**1.20**	**1.31**	**1.17**
Days to gain 160 pounds	122	126	124	133	123	137
Daily feed per pig, pounds:						
Corn	4.24	4.24	4.17	3.85	4 27	3.59
Tankage	.42	.37	.39	.27	.38	....
Linseed meal	.42					
Soybean oil meal	....	.37	.39	.53	.38	.45
Cottonseed meal	....	....	....	....	....	.45
Ground alfalfa	.21	.21	.22	.21	.22	.19
Minerals	.08	.08	.08	.08	.09	.12
Total	5.37	5.27	5.25	4.94	5.34	4.80
Feed per 100 pounds of gain, pounds:						
Corn	322.94	332.56	322.06	219.57	327.27	305.76
Tankage	31.67	28.69	29.87	22.05	29.20	....
Linseed meal	31.67					
Soybean oil meal	....	28.69	29.87	44.10	29.20	38.60
Cottonseed meal	....	....	....	....	....	38.60
Ground alfalfa	16.35	16 52	17.21	17.64	16.35	16.36
Minerals	6.19	6.61	6.06	6.80	6.67	9.80
Total	**408.82**	**413.07**	**405.07**	**410.16**	**408.69**	**409.12**
Cost of feed per 100 pounds of gain	$8.60	$8.45	$8.34	$8.34	$8.40	$8.15

For the groups as named, the pig days were 4,634, 4,823, 5,958, 5,866, 3,381, and 3,542; the total gains were 6,089.2, 6,154.7, 7,720.3, 7,065.5, 4,414.3, and 4,156.3 pounds, respectively.

For prices, see footnote to table 1.

weights of soybean oil meal and tankage and feeding twice as much soybean oil meal as tankage were compared. The pigs fed equal amounts of the two required an average of 5 pounds less feed per 100 pounds of gain produced and were ready for market 9 days earlier, on the average, than those fed the two to one mixture.

In one of the trials, toasted extracted soybean oil meal was fed for 53 days and expeller soybean oil meal thereafter. Expeller meal was used in one, and toasted extracted meal in two, of the other three trials. Without exception, the pigs fed the 1:1 mixture outgained those fed the 2:1 mixture. In one trial there was no difference in the feed required per unit of gain. In one in which toasted extracted meal was used, the pigs having the 2:1 mixture required less feed per unit of gain than those having the 1:1 mixture. In the remaining two, the pigs having the 1:1 mixture required less feed per unit of gain than those having the 2:1 mixture.

MIXTURE OF PLANT PROTEIN CONCENTRATES

Part 3 of table 5 summarizes two comparisons of a mixture of tankage and soybean oil meal with a mixture of soybean oil meal and cottonseed

meal. Both were fed with corn, ground alfalfa, and minerals to pigs in dry lot. The pigs fed tankage ate more feed daily a head, gained more rapidly, and were ready for market 2 weeks earlier than those fed cottonseed meal with soybean oil meal. The cottonseed meal was made by the expeller process and was treated with a solution of ferrous sulfate to overcome any possible toxic effect it may have had. The solution was made by dissolving 2 pounds of ferrous sulfate in 10 quarts of water. It was mixed with the cottonseed meal at the rate of 10 quarts to each 100 pounds of meal. There was no difference in the feed required per unit of gain by the pigs on the two rations.

sons of tankage and expeller soybean oil meal for feeding with corn and minerals to pigs on pasture. In one trial, the pasture was a mixture of medium red clover and alfalfa. In the others, it was Dwarf Essex rape. The feeds were mixed so that, regardless of the supplement, each ration contained approximately the same percentage of protein and the same percentage of minerals. The pigs fed soybean oil meal ate 7 per cent more feed daily a head and made a trifle faster gains but required a little more feed per unit of gain than those fed tankage. At the prices used, the ration containing soybean oil meal was more economical than the one containing tankage.

TABLE 6.—Soybean oil meal for pigs on pasture

	Corn Tankage Minerals	Corn **Expeller soybean oil meal** Minerals
Number of comparisons	4	4
Pigs at start	55	55
Initial weight per pig, pounds	57.5	57.4
Pigs at close	53	55
Final weight per pig, pounds	207.7	209.8
Average daily gain, pounds	**1.41**	**1.45**
Days to gain 160 pounds	114	111
Daily feed per pig, pounds:		
Corn	4.64	4.73
Tankage	.39	....
Soybean oil meal	....	.63
Minerals	.07	.11
Total	5.10	5.47
Feed per 100 pounds of gain, pounds:		
Corn	328.46	325.83
Tankage	27.41	....
Soybean oil meal	....	43.10
Minerals	4.86	7.66
Total	**360.73**	**376.59**
Cost of feed per 100 pounds of gain	$7.34	$7.24
Cost of feed and pasture per 100 pounds of gain	$8.05	$7.93
Worth of soybean oil meal with tankage as 100 per cent	....	63.0%

For the two groups, the pig days were 5,726 and 5,775; the total gains were 8,090.2 and 8,384.7 pounds, respectively.

For prices, see footnote to table 1.

ON PASTURE

SOYBEAN OIL MEAL

Good pasture tends to correct the deficiencies that may exist in the concentrate portion of the ration. Table 6 gives the results of four compari-

MIXTURE OF PLANT PROTEIN CONCENTRATES

Table 7 summarizes two trials on mixed clover and alfalfa, and one on Dwarf Essex rape, pasture in which supplements of tankage, of soybean oil meal, and of a mixture of soybean

TABLE 7.—A mixture of plant protein concentrates for pigs on pasture

	1	2	3
	Corn Tankage Minerals	Corn Soybean oil meal Minerals	Corn Soybean oil meal Cottonseed meal Minerals
Number of comparisons	3	3	3
Pigs at start	59	60	60
Initial weight per pig, pounds	53.5	53.1	53.6
Pigs at close	55	59	55
Final weight per pig, pounds	207.2	207.5	214.3
Average daily gain, pounds	**1.33**	**1.40**	**1.43**
Days to gain 160 pounds	121	115	112
Daily feed per pig, pounds:			
Corn	4.35	4.49	4.45
Tankage	.41		
Soybean oil meal		.66	.38
Cottonseed meal			.30
Minerals	.07	.13	.13
Total	4.83	5.28	5.26
Feed per 100 pounds of gain, pounds:			
Corn	327.05	321.15	310.93
Tankage	30.28		
Soybean oil meal		47.25	26.46
Cottonseed meal			21.27
Minerals	5.45	9.22	8.96
Total	**362.78**	**377.62**	**367.62**
Cost of feed per 100 pounds of gain	$7.45	$7.29	$7.19
Cost of feed and pasture per 100 pounds of gain	$8.20	$8.01	$7.89
Worth of protein concentrate with tankage as 100 per cent		65.6%	74.5%

The pig days for groups 1, 2, and 3 were 6,461, 6,559, and 6,349; the total gains were 8,596, 9,179.5, and 9,091.7 pounds, respectively.
For prices, see footnote to table 1.

oil meal and cottonseed meal were compared for feeding with corn and minerals. Expeller soybean oil meal was used in two, and toasted extracted soybean oil meal in one, of the three experiments. Lot 3 was fed a pound of cottonseed meal to 2 pounds of soybean oil meal in one trial, and equal amounts of the two supplements in the other two trials. The pigs fed the mixture took no more feed daily a head but made slightly faster gains and slightly greater gains per unit of feed consumed than those fed only soybean oil meal as a protein supplement.

The results of an experiment on pasture conducted in 1942 are reported in table 8. There was practically no difference in the performance of pigs fed a mixture of soybean oil meal, 2; tankage, 1; and of pigs fed soybean oil meal as the protein supplement.

Pigs fed a protein mixture of soybean oil meal, 4; cottonseed meal, 1; linseed meal, 1, made slightly greater gains per unit of feed consumed than pigs fed soybean oil meal alone as the protein feed. Further tests are necessary to determine whether the results of the single trial were representative.

The experiments for which data are presented and other investigations showed that when they were fortified with minerals, plant protein concentrates were satisfactory for pigs on good pasture. Good pasture is pasture that is palatable and ample. Pasture tends to overcome the deficiencies that may exist in the concentrate portion of the ration. Rations that are faulty in some respect for pigs in dry lot may be satisfactory for pigs on pasture. Providing pasture for as much of the year as possible will aid greatly in solving the problem of a shortage of animal protein feeds. Although not conclusive, what evidence was obtained indicates that a mixture of plant protein concentrates may have an advantage over a single plant protein concentrate.

TABLE 8.—Soybean oil meal in various combinations for pigs on pasture

Experiment started June 17, 1942 Feeds mixed and self-fed	1	2	3	4	5
	Ground corn, minerals				
	Tankage	**Expeller soybean oil meal**	**Expeller soybean oil meal, 4 Cottonseed meal, 1 Linseed meal, 1**	**Tankage, 1 Expeller soybean oil meal, 2**	**Expeller soybean oil meal, 2 Cottonseed meal, 1**
Pigs at start	20	20	20	20	20
Initial weight per pig, pounds	62.4	61.6	62.5	61.7	62.4
Pigs at close	20	20	19	18	18
Final weight per pig, pounds	218.6	213.9	216.3	217.5	217.4
Average daily gain, pounds	**1.49**	**1.45**	**1.47**	**1.46**	**1.42**
Days to gain 160 pounds	108	111	109	110	113
Daily feed per pig, pounds:					
Corn	4.81	4.50	4.36	4.67	4.49
Supplement	.46	.68	.72	.58	.71
Minerals	.08	.13	.13	.11	.13
Total	5.35	5.31	5.21	5.36	5.33
Feed per 100 pounds of gain, pounds:					
Corn	323.36	310.53	295.90	319.83	315.80
Supplement	30.59	46.49	49.02	39.99	49.74
Minerals	5.35	9.00	8.69	7.57	9.21
Total	**359.30**	**366.02**	**353.61**	**367.39**	**374.75**
Cost of feed per 100 pounds of gain	$7.39	$7.07	$6.92	$7.30	$7.32
Cost of feed and pasture per 100 pounds of gain	$8.07	$7.76	$7.60	$7.98	$8.02
Worth of plant protein concentrate with tankage as 100 per cent	....	73.9%	83.4%	66.4%	64.3%

The pig days for lots 1 to 5 were 2,100, 2,100, 2,023, 1,974, and 2,002; the total gains were 3,125.0, 3,046.0, 2,978.0, 2,881.2, and 2,847.5, respectively.
For prices, see footnote to table 1.

COMPARISON OF FIXED COPPERS AND BORDEAUX MIXTURE IN THE CONTROL OF INSECTS AND DISEASES ON MUCK-GROWN IRISH COBBLER POTATOES

J. P. SLEESMAN AND J. D. WILSON

Copper sulfate applied to potatoes in the form of bordeaux mixture is a standard material for the control of the potato leafhopper (*Empoasca fabae* Harris), the potato flea beetle (*Epitrix cucumeris* Harr.), early blight (*Alternaria solani* J. & G.), and late blight (*Phytophthora infestans* DeB.). The purpose of this paper is to present data concerning the effectiveness of various formulas of bordeaux mixture, several fixed copper compounds, sulfur, and combinations of these materials with certain toxicants, in insect and disease control on muck-grown Irish Cobbler potatoes.

REVIEW OF THE LITERATURE

Several investigators in recent years have studied the effect of modifying the copper-lime ratio of the bordeaux formula. Blodgett et al. (1) obtained good results from the use of a bordeaux mixture in which the lime content was reduced to one-half that of the copper sulfate. Whipple and Allen (2) found a bordeaux mixture prepared with the same quantities of lime and copper sulfate to be equal or superior to any other ratio. Work by Bonde (3) has shown that the lime content in the formula can be reduced profitably to one-half that of the copper sulfate. Mader et al. (4) report that an increase in yield was obtained by varying the concentration so as to apply the greater part of the copper sulfate early in the season. Increased yields from the addition of calcium arsenate to bordeaux mixture to control the potato flea beetle have been reported by Anderson and Walker (5, 6), Gui (7), Wolfenberger (8), Munro and Schifino (9), and Simpson (10). Differences in yield were either small, not significant (5, 6, 7), or could hardly be explained by the accompanying reduction in adult flea beetle injury (7, 8, 9). Wolfenberger (8) and Munro and Schifino (9) suggest that the increases in yield may have been due to some factor, or group of

1. Blodgett, F. M., E. O. Mader, O. D. Burke, and R. B. McCormack. 1935. Three years' results using bordeaux mixture with reduced amounts of lime as a potato spray. Amer. Potato Jour. 12: 171-177.
2. Whipple, O. C., and T. C. Allen. 1941. Three years of potato spraying in southeastern Wisconsin. Amer. Potato Jour. 18: 254-261.
3. Bonde, Reiner. 1942. Potatoes. Maine Agr. Exp. Sta. Bull. 411-C: 305-308.
4. Mader, E. O., and F. M. Blodgett. 1935. Effects of modification of the potato spray program. N. Y. (Cornell) Agr. Exp. Sta. Bull. 621: 1-34.
5. Anderson, L. D., and H. G. Walker. 1934. The life history and control of the potato flea beetle, *Epitrix cucumeris* Harris, on the eastern shore of Virginia. Jour Econ. Ent. 27: 102-106.
6. Anderson, L. D., and H. G. Walker. 1940. Results of a nine-year study of potato flea beetle control in eastern Virginia. Trans. Penn. Hort. Soc., Del. State Bd. Agr. 30 (4): 17-24.
7. Gui, Harry L. 1938. Potato flea beetles and their control. Ohio Agr. Exp. Sta. Bull. 595: 1-29.
8. Wolfenberger, D. O. 1934. Some effects on potato flea beetle injuries and yields by spraying. Jour. Econ. Ent. 27: 118-120.
9. Munro, J. A., and L. A. Schifino. 1938. Potato spraying experiments in North Dakota. Jour. Econ. Ent. 31: 485-487.
10. Simpson, G. W. 1934. Control of flea beetles on potatoes. Maine Agr. Exp. Sta. Bull. 377: 351-353.

factors, other than reduction of flea beetle injury. Anderson and Walker (5, 6) have presented data that permit direct comparisons between bordeaux mixture alone and bordeaux mixture with calcium arsenate. These data are variable and inconclusive as to the value of calcium arsenate in combination with bordeaux mixture for the control of the potato flea beetle. Simpson (10) concluded that the increase in yield obtained with bordeaux mixture plus calcium arsenate over bordeaux mixture alone was too small to warrant the use of the arsenical. MacLeod (11) found that adequate protection from potato flea beetle damage could be secured with a variety of bordeaux formulas. Mader et al. (12) presented data to show that 90 per cent of the flea beetle damage could be eliminated with bordeaux mixture and that the flea beetle population was progressively decreased by increasing the amount of copper sulfate up to 48 pounds per acre per season.

Dusting sulfur has been found by DeLong (13, 14) to give good control of the potato leafhopper and to have a residual value. Mader et al. (12) and Skaptason and Blodgett (15) showed sulfur to give slightly better control of the potato leafhopper than bordeaux mixture, but the lack of a significant increase in yield over the unsprayed plots indicated that the material had a harmful effect on the plant. Menusan (16) found plots treated with sulfur dust when the foliage was dry to give consistent, but usually not significant, increases in tuber yields over plots treated with copper-lime dust.

Investigations conducted by DeLong (13, 14), Walker and Anderson (17), Allen (18), Mader et al. (12), Skaptason (15), Menusan (16), Watkins (19), and Daines et al. (20) have shown rotenone to be effective in reducing flea beetle populations, and pyrethrum to be toxic to the leafhopper. DeLong (14) and Walker and Anderson (17) found these materials to have no lasting toxic effect. Combining rotenone and pyrethrum with a sulfur dust appears to have some merit, according to results discussed by Skaptason and Blodgett (15), Menusan (16), Daines et al. (20), and Skaptason (21). Daines et al. (20) suggest that consideration must be given in commercial potato production to the extremely high cost of such a dust mixture and to the degree of protection that it affords against leaf diseases.

11. MacLeod, C. F. 1939. A review of the potato insect problems in New York State. Amer. Potato Jour. 16: 232-236.
12. Mader, E. O., W. A. Rawlins, and E. C. Udey. 1938. The interaction of bordeaux mixture spray, sulfur, and pyrethrum dusts on potato yields and insect control. Amer. Potato Jour. 15: 337-349.
13. DeLong, D. M. 1934. The relative value of bordeaux mixture, sulfur and pyrethrum products in reducing populations of the potato leafhopper (*Empoasca fabae* Harris). Jour. Econ. Ent. 27: 525-533.
14. DeLong, D. M. 1938. Studies of methods and materials for the control of the leafhopper *Empoasca fabae* as a bean pest. U. S. D. A. Tech. Bull. 740: 1-63.
15. Skaptason, J. B., and F. M. Blodgett. 1941. Factorial studies on potato dusting materials. Amer. Potato Jour. 18: 1-9.
16. Menusan, Henry, Jr. 1938. Results of potato dusting experiments on organic soils. Jour. Econ. Ent. 31: 259-262.
17. Walker, H. G., and L. D. Anderson. 1935. Summary of results obtained with arsenical substitutes for the control of vegetable crop insects at Virginia Truck Experiment Station. Jour. Econ. Ent. 28: 603-605.
18. Allen, T. C. 1936. Toxicity of kerosene steepates of derris and pyrethrum to some potato insects. Jour. Econ. Ent. 29: 742-743.
19. Watkins, T. C. 1941. Toxicities of bordeaux mixture, pyrethrum and derris to potato leafhoppers. Jour. Econ. Ent. 34: 362-363.
20. Daines, R. H., J. C. Campbell, and W. H. Martin. 1942. Three years' comparisons of dusts and bordeaux spray for potato production in central Jersey. Amer. Potato Jour. 19: 90-96.
21. Skaptason, J. B. 1938. Some comparisons of dusts for potato leafhopper control on Long Island. Amer. Potato Jour. 15: 271-277.

MacDaniel (22) has shown that a white coating of lime on the leaves of potatoes is a repellent to the potato leafhopper. According to DeLong (14), lime has no toxic effect on this insect.

The use of fixed copper compounds to control vegetable diseases has been studied by Wilson and Runnels (23) and by Wilson (24, 25). Whipple and Allen (2) and Bonde (3) found several of the fixed coppers to give equally as good results as bordeaux mixture, providing the metallic copper content was the same for the formulas compared. Significant reduction in potato leafhopper and flea beetle populations from the use of fixed coppers was reported in a paper by Skaptason and Blodgett (15).

MATERIALS AND METHODS

The experiments herein reported have been concerned with the effectiveness of various bordeaux formulas, of copper-lime dust, of sulfur dust, of fixed copper compounds, and of these materials in combination with various toxicants, adhesives, and diluents in the control of insects and diseases attacking the Irish Cobbler potato.

All treatments were applied to plots one row wide and 50 feet long (26, 27), replicated five times in randomized blocks. A buffer row was used on each side of each treated plot.

The sprays were applied with an adjustable three-nozzle hand-operated boom under a pressure of 300 pounds. Application of the dust mixtures was made with a Root hand duster. At the time of maximum foliage development, 250 gallons of spray material or 75 pounds of dust per acre were required to provide thorough and complete coverage. The first application of the sprays or dusts was made when the plants were about 6 inches in height. Others followed at 10-day intervals until the vines were dead, unless otherwise indicated.

Leafhopper populations were determined by counting the nymphs on 10 leaves selected at random from each plot. Since the nymphs seldom leave the plant, they can be counted readily upon an individual leaf, whereas the adult leafhoppers are very active and move freely from plant to plant. Thus, the nymphal count was considered to be the better index of relative populations.

Flea beetle populations were not determined by actual count of the insects. The number of adult feeding punctures in a unit area of leaf surface was considered to be a more reliable index to the size of the adult population. A sample of 20 leaves was selected at random from each plot, and the number of feeding punctures was counted in a circular area 1.5 centimeters in diameter taken from that portion of the leaf where injury was heaviest.

The degree of foliage protection was determined by estimating the percentage of dead foliage for each plot on a given date. During the course of these experiments, hopperburn represented the most serious injury to the foliage, but in certain

22. MacDaniel, E. I. 1937. White coating on foliage a repellent for potato leafhopper. Jour. Econ. Ent. 30: 454-457.
23. Wilson, J. D., and H. A. Runnels. 1938. Insoluble copper compounds as vegetable sprays. Ohio Agr. Exp. Sta. Bimo. Bull. 23: 48-55.
24. Wilson, J. D. 1940. Certain injurious effects of spraying vegetables with fixed coppers. Ohio Agr. Exp. Sta. Bimo. Bull. 25: 36-43.
25. Wilson, J. D. 1941. Further studies on the use of fixed copper compounds for the control of vegetable diseases. Proc. Ohio Vegetable and Potato Growers' Assoc. 26: 20-33.
26. Menusan, Henry, Jr. 1935. Size of plot and its relationship to field spraying experiments with potatoes. Jour. Econ. Ent. 28: 190-192.
27. Sleesman, J. P. 1936. Uniformity experiment with potatoes. Unpublished data.

years, either early or late blight was a contributing factor.

Whenever direct comparisons were to be made between copper compounds, the formulas were prepared so that the copper contents (expressed as metallic) were approximately equal. The copper content, stated as the metallic equivalent, of most of the fixed coppers used in these experiments was listed in a paper by Wilson and Vogel (28). Other specifications were given by Wilson and Irons (29).

The experiments were conducted on muck soil at McGuffey, Ohio, from 1934 to 1942, inclusive. The potato leafhopper and the potato flea beetle were factors in reducing yields each year; early blight was a factor in 1935 and late blight, in 1938.

PRESENTATION OF DATA

Tables 1 and 2 present data on leafhopper populations and yields obtained from plots treated with bordeaux mixture, copper-lime dust, Sulfuron (wettable sulfur), sulfur-lime dust, and a specially prepared dust in which sulfur was combined with pyrethrum. In 1935, two grades of pyrethrum were used; one contained 0.1 per cent and the other 0.05 per cent pyrethrin. The pyrethrin-bearing materials were mixed with sulfur in proportions that gave different amounts of pyrethrin in the finished dust. Ground derris root also was combined with sulfur in a dust formula that contained 0.75 per cent of rotenone. The addition of these toxicants to sulfur did not reduce the leafhopper population nor increase the yield. Copper-lime dust carefully applied under optimum conditions gave results comparable to those obtained with bordeaux mixture.

Table 3 shows the effect of modifying the amount of lime in the bordeaux formula and of varying the concentration to apply the greater amount of copper sulfate early or late in the season. Plots sprayed with an 8-2-100 bordeaux mixture gave a significantly higher yield, and the tops remained green longer than those treated with an 8-12-100 mixture. Yields were not significantly affected by a schedule in which the greater amount of copper sulfate was

TABLE 1.—Influence of treatments on leafhopper populations and the yield of potatoes in 1934, based on the means of five replications

Treatment	Nymphs per 100 leaves	Bushels per acre
May 20 planting		
8-12-100 bordeaux	32	347
8-12-100 bordeaux (20-day interval)	308	247
20-80 copper-lime dust	40	345
Sulfur-pyrethrum dust 90-10 (0.1 per cent pyrethrin)	32	332
June 20 planting		
8-12-100 bordeaux	52	287
Sulfur-pyrethrum dust 90-10 (0.1 per cent pyrethrin)	40	270
Sulfuron, 10-100	156	227
Untreated	336	196

Difference between means required for significance at the 5 per cent level is 22 and 25 bushels per acre for May 20 and June 20, respectively.

28. Wilson, J. D., and M. A. Vogel. Density and flowability of insecticidal and fungicidal dusts and dust ingredients. Ohio Agr. Exp. Sta. Bimo. Bull. 26: 69-79.
29. Wilson, J. D., and Frank Irons. 1942. Specifications of some of the ingredients commonly used in fungicidal dust mixtures. Ohio Agr. Exp. Sta. Bimo. Bull. 27: 26-41.

TABLE 2.—Leafhopper populations and yield for the treatments shown, based on the means of five replications, 1935

Treatment	Nymphs per 100 leaves	Bushels per acre
8-12-100 bordeaux	24	286
16-8-100 bordeaux	32	303
Sulfur-lime, 90-10	24	325
Sulfur-pyrethrum, 95-5 (0.05 per cent pyrethrin)	32	332
Sulfur-pyrethrum, 75-25 (0.0125 per cent pyrethrin)	44	343
Sulfur-pyrethrum, 87-13 (0.0063 per cent pyrethrin)	40	340
Sulfur-derris, 85-15	52	342
20-80 copper-lime dust	80	350
Untreated	324	307

A difference of 45 between mean yield values is required for significance at the 5 per cent level.
A difference of 27 between mean nymphal population values is required for significance at the 5 per cent level.

applied early in the season, and the results were not very different when the schedule was reversed. Increasing the copper sulfate in the bordeaux formula from 8 to 10 pounds showed a slight advantage. The yield obtained with a 20-80 copper-lime dust was comparable to that obtained with an 8-12-100 bordeaux mixture although the leafhopper population was slightly higher. Sulfur-lime dust gave good control of the potato leafhopper, but the tops died earlier, and the yield was lower than that of bordeaux-sprayed plots.

TABLE 3.—Leafhopper populations, foliage condition, and yield for the treatments shown, based on the means of five replications, 1936

Treatment	Nymphs per 100 leaves	Per cent of foliage dead on September 1	Bushels per acre
8-12-100 bordeaux	105	50	474
8-4-100 bordeaux	90	50	485
8-2-100 bordeaux	75	20	527
10-5-100 bordeaux	70	25	521
20-10-100 bordeaux	90	10	507
10-5-100* bordeaux	75	10	546
4-2-100† bordeaux	105	10	539
20-10-100 bordeaux (20 day interval)	105	75	455
Copper oxychloride "B" dust	120	100	459
20-80 copper-lime dust	260	100	471
Sulfur-lime dust, 90-10	200	100	444
Untreated	1,043	100	272

*10-5-100 followed by 10-5-100, 20-10-100, 10-5-100, 5-2½-100, 4-2-100, 4-2-100.
†4-2-100 followed by 4-2-100, 5-2½-100, 10-5-100, 20-10-100, 10-5-100, 10-5-100.
A difference of 48 between mean yields is required for significance at the 5 per cent level.
A difference of 65 between mean nymphal population values is required for significance at the 5 per cent level.

Table 4 gives data comparing various bordeaux formulas, copper-lime dust, and sulfur dust. Reducing the amount of lime in the bordeaux formula did not result in significant differences in yield. Varying the concentration of the formula to apply the greater amount of copper sulfate early in the season again did not show any advantage over a uniform schedule. The addition of a spreading agent to several bordeaux formulas was of no benefit. Plots which were "double-sprayed" (foliage sprayed, allowed to dry, and re-sprayed) with bordeaux mixture gave a significantly higher yield than those plots regularly sprayed with a similar material. Copper-lime dust was equally as good as bordeaux mixture, but a sulfur-lime dust was of little benefit.

TABLE 4.—Foliage condition and yield for the treatments shown, based on the means of five replications, 1937

Treatment	Per cent of foliage dead on August 10	Bushels per acre
10-20-100 bordeaux	48	355
10-15-100 bordeaux	48	363
10-10-100 bordeaux	43	353
10-5-100 bordeaux	48	349
10-2½-100 bordeaux	45	361
10-5-100* bordeaux	48	377
10-2½-100† bordeaux	43	346
10-5-100 bordeaux (14-day interval)	65	359
10-5-100 bordeaux (21-day interval)	90	324
10-5-100 bordeaux plus spreader	42	348
10-2½-100 bordeaux plus spreader	46	354
20-80 copper-lime dust	50	347
Sulfur-lime dust, 90-10	95	254
Untreated	100	232
10-5-100 bordeaux (double-sprayed)	33	398

A difference of 44 bushels per acre between means is required for significance at the per cent level.

*10-5-100, 20-10-100, 20-10-100, 12-6-100, 6-3-100, 4-2-100, 4-2-100.

†10-2½-100, 20-5-100, 20-5-100, 12-3-100, 6-1½-100, 4-1-100, 4-1-100.

Table 5 presents data on the reduction of leafhopper populations, the degree of foliage protection, and the yields obtained from 15 different treatments. Plots sprayed with a high- and a low-lime bordeaux mixture did not show significant differences in yield. Sulfur, used both as a spray and as a dust, gave good leafhopper control but a poor foliage score and low yields. The addition of sulfur to bordeaux mixture and to copper-lime dust did not increase the yield over that obtained when these materials were used alone. Hydrated lime and Nicotine 155 applied in spray formulas gave poor leafhopper control and poor yields, and the tops of the plants died as quickly as those of untreated plots. Several of the fixed copper compounds applied as sprays gave yields comparable to those obtained with bordeaux mixture. With the exception of Coposil, none of the fixed coppers controlled the leafhopper so well as bordeaux mixture. During the latter part of July, an outbreak of late blight oc-

TABLE 5.—Leafhopper populations, foliage condition, and yield for the treatments shown, based on the means of five replications, 1938

Treatment	Nymphs per 100 leaves	Per cent of foliage dead on		Bushels per acre
		July 25	August 8	
CAC plus flour, 5-6-100	235	5	93	387
Cupro-K plus flour, 10-6-100	306	10	98	355
Coposil plus flour, 10-6-100	48	4	84	408
Cuprocide plus flour, 3-6-100	370	12	99	345
Copper 34 plus flour, 6-6-100	253	9	100	384
Bordeaux, 10-15-100	6	1	78	402
Bordeaux, 10-5-100	18	0	78	392
Bordeaux, 30-15-100 (20-day interval)	45	7	89	382
Sulfur, 10-100	106	47	100	313
Lime only, 15-100	866	84	100	246
Nicotine 155, 6-100	431	70	100	257
Bordeaux, 10-5-100, plus sulfur, 10 pounds	1	0	73	412
Sulfur-lime dust, 90-10	10	70	100	241
20-80 copper-lime dust	1	0	69	456
20-80 copper-lime, 1 part; Sulfur, 1 part	0	0	77	426
Untreated	1,066	88	100	207

A difference of 33 between mean yield values is required for significance at the 5 per cent level.
A difference of 132 between mean nymphal population values is required for significance at the 5 per cent level.

curred and, since it is difficult in a casual examination to separate hopperburn from late blight injury, the total necrosis of the leaves can be attributed to these factors acting together.

Table 6 summarizes the data obtained from plots treated with 23 different spray and dust formulas. All the various bordeaux formulas gave about the same degree of foliage protection, and the yields were

TABLE 6.—Foliage condition and yield for the treatments shown, based on the means of five replications, 1939

Treatment	Per cent of foliage dead on		Bushels per acre
	August 14	August 22	
Bordeaux, 8-8-100	0	88	574
Bordeaux, 10-10-100	0	88	565
Bordeaux, 12-12-100	0	88	573
Bordeaux, 10-15-100	0	88	612
Bordeaux, 10-5-100	0	90	574
Bordeaux, 10-5-100, plus 4 pounds of calcium arsenate	0	90	557
Bordeaux, 10-5-100, plus 10 pounds of sulfur	0	97	512
Bordeaux, 20-10-100	0	90	549
Bordeaux, 30-15-100 (20-day interval)	0	90	568
Bordeaux, 10-20-100	0	88	586
Lime only, 20-100	54	100	540
Basic Copper Arsenate plus flour, 6-6-100	66	100	509
COC-S plus flour, 5-6-100	23	100	588
Coposil plus flour, 10-6-100	0	90	610
Cuprocide 54 Y plus flour, 3-6-100	0	90	609
Copper Hydro-40 plus flour, 10-6-100	25	100	589
Copper A Compound plus flour, 5-6-100	0	90	604
20-80 copper-lime dust	0	33	611
30-70 copper-lime dust	0	25	604
20-80 copper-lime, 1 part; Sulfur, 1 part	0	63	576
Sulfur-lime, 80-20	25	97	562
Sulfur-Coposil, 75-25	0	83	599
Copper A Compound-derris-sulfur, 13-20-67	0	50	611
Copper A Compound-sulfur, 13-87	0	88	578
Untreated	58	100	472

A difference of 67 between means is required for significance at the 5 per cent level.

not significantly different. The addition of sulfur to bordeaux mixture again tended to reduce the yield. A 1:1 mixture of copper-lime dust and sulfur was a little less effective than copper-lime dust alone. Several of the fixed copper compounds gave results comparable to those secured with bordeaux mixture. Basic Copper Arsenate provided poor foliage protection, and the yield was low; in fact, this material was little, if any, high as that of the untreated plots. A combination dust of a fixed copper and sulfur and a mixture of a fixed copper, derris, and sulfur did not show any advantage over copper-lime dust. The addition of calcium arsenate to bordeaux mixture was of no benefit.

Table 7 shows the yields obtained from plots treated with several bordeaux mixture and fixed copper form-

TABLE 7.—Yield for the treatments shown, based on the means of five replications, 1940

Treatment	Bushels per acre	Treatment	Bushels per acre
10-15-100 bordeaux	340	Tribasic-flour-talc, 14-14-72	389
10-5-100 bordeaux	352	Copper A Compound-flour-talc, 14-14-72	382
10-5-100 bordeaux plus 4 pounds of calcium arsenate	360	Cuprocide-flour-talc, 8-14-78	356
30-15-100 bordeaux (20-day interval)	362	Sulfur-derris-talc, 70-15-15	395
Tribasic-flour, 5-6-100	344	20-80 copper-lime dust	355
		Untreated	333

A difference of 39 between mean yield values is required for significance at the 5 per cent level.

more effective than hydrated lime. In a subsidiary experiment, plots which were treated with Basic Copper Arsenate showed a leafhopper population which was practically as ulas. The differences in yield between the various treatments and the untreated plots were not so large as in previous experiments, and in many instances they were not significant.

TABLE 8.—Leafhopper populations, foliage condition, and yield for the treatments shown, based on the means of five replications, 1941

Treatment	Nymphs per 100 leaves*	Per cent of foliage dead on August 6	Per cent of foliage dead on August 14	Bushels per acre†
10-15-100 bordeaux	102	23	78	517
10-5-100 bordeaux	24	16	61	520
10-15-100 bordeaux plus calcium arsenate, 4 pounds	98	18	76	535
10-15-100 bordeaux plus Cal Zinc, 4 pounds	46	20	70	525
R64 Niagara Spray, 20-100	46	27	75	515
COC-S-fused bentonite-sulfur, 5-2-100	340	45	92	473
COC-S-flour-sticker, 5-6½-100	348	41	84	513
COC-S-sticker, 5½-100	228	41	78	517
Copper A Compound-flour-sticker, 5-6½-100	418	39	87	502
Cuprocide-flour-sticker, 3-6½-100	872	62	98	457
Tribasic-flour-sticker, 5-6½-100	674	56	96	460
Rus Far Dust No. 9 (Tribasic plus derris plus pyrethrum)	122	13	81	487
COC-S-sulfur-talc, 14-30-56	2	10	60	508
COC-S-bentonite-E M talc, 14-14-72	4	12	65	522
COC-S-bentonite-Carbola talc, 14-14-72	4	12	69	527
COC-S-bentonite-Pyrax ABB, 14-14-72	0	10	50	529
20-80 copper-lime dust	16	10	50	557
Untreated	1,276	78	100	425

*A difference of 141 between mean values is required for significance at the 5 p level.

†A difference of 70 between mean values is required for significance at the 5 per cent level.

Table 8 summarizes the data obtained from plots that received 19 different spray and dust formulas. The differences in yield, leafhopper populations, and foliage scores from plots treated with different bordeaux formulas are not significant. The addition of calcium arsenate to bordeaux mixture did not result in a significant increase in yield over that obtained with bordeaux mixture alone. Several fixed copper compounds gave results comparable to those obtained with bordeaux mixture. When four fixed coppers were compared in spray formulas, the rankings from highest to lowest were copper oxychloride-sulfate (COC-S), Copper A Compound, Tribasic, and Cuprocide Y. COC-S used with bentonite as an adhesive and different talcs as diluents gave excellent yields, leafhopper control, and foliage scores. The addition of sulfur to COC-S was of no benefit; in fact, the yield was reduced slightly below that obtained with comparable formulas from which the sulfur was omitted. A dust mixture of Tribasic, derris, and pyrethrum gave a yield below that of bordeaux-treated plots. The use of several different adhesives with COC-S was of little benefit.

Table 9 presents data on yield, leafhopper populations, and degree of foliage protection for 23 different treatments. A high- and a low-lime bordeaux mixture gave equally good yields, leafhopper control, and foliage scores. The addition of calcium arsenate to bordeaux mixture and to COC-S dust resulted in a slightly, but not significantly, greater yield than was obtained when it was omitted. The addition of sulfur to three fixed coppers was of doubtful value, with the exception of the addition Tribasic, which showed fewer leafhopper nymphs and a small, but not significant, increase in yield when sulfur

TABLE 9.—Leafhopper populations, foliage condition, and yield for the treatments shown, based on the means of five replications, 1942

Treatment	Nymphs per 100 leaves	Per cent of foliage dead on August 10	Bushels per acre
10-15-100 bordeaux	114	42	528
10-15-100 bordeaux plus 4 pounds of calcium arsenate	148	38	541
Tribasic-bentonite-sulfur-E M Talc (14-14-20-52)	140	41	509
Cuprocide-bentonite-sulfur-E M Talc (8-14-20-58)	144	49	465
COC-S-bentonite-sulfur-E M Talc (14-14-20-52)	98	42	520
COC-S-bentonite-sulfur-Pyrax ABB (14-14-20-52)	156	34	524
COC-S-bentonite-sulfur-E M Talc (14-14-10-62)	102	41	535
COC-S-bentonite-sulfur-E M Talc (14-14-30-42)	106	27	540
COC-S-bentonite-calcium arsenate-Pyrax ABB (14-14-10-62)	188	41	510
COC-S-bentonite-derris-Pyrax ABB (14-14-15-57)	132	30	519
COC-S-bentonite-pyrethrum-Pyrax ABB (14-14-10-62)	78	32	548
Copper Hydro arsenate-bentonite-E M Talc (13-14-56)	80	32	524
Fermate-E M Talc (90-10)	124	14	585
Copper A Compound-bentonite-E M Talc (14-14-72)	174	44	493
Tribasic-bentonite-E M Talc (14-14-72)	282	55	445
COC-S-bentonite-E M Talc (14-14-72)	106	43	511
Cuprocide-bentonite-E M Talc (8-14-78)	124	34	508
COC-S-bentonite-Pyrax ABB (14-14-72)	128	43	502
COC-S-bentonite-Cherokee clay (14-14-72)	140	44	500
Cuprocide-Cherokee clay (8-92)	180	51	486
Pyrax ABB only	672	84	417
10-5-100 Bordeaux	154	30	529
COC-S-flour (5-6-100)	182	38	530
Untreated	816	79	375

A difference of 70 between mean yield values is required for significance at the 5 per cent level.

A difference of 107 between mean nymphal population values is required for significance at the 5 per cent level.

was included in the formula. The use of several different diluents with COC-S did not affect the yield. Combining derris and pyrethrum with COC-S was of little benefit. Fermate gave the highest yield, and the vines treated with it remained green longer than those that received any other treatment. Pyrax ABB applied as a dust resulted in poor leafhopper control, poor foliage protection, and low yield.

Table 10 shows the number of adult flea beetle feeding punctures per 1.5-centimeter leaf disc for four different formulas. In a 4-year test, the addition of calcium arsenate to bordeaux mixture caused no significant reduction in the number of adult feeding punctures over bordeaux mixture used alone. In the 1942 experiment, COC-S combined with derris and with pyrethrum showed a reduction in the number of feeding punctures comparable to that provided by bordeaux mixture.

Simple coefficients of correlation between several variables are shown in table 11. Leafhopper nymphal population is closely correlated with the percentage of dead foliage and with yield. Likewise, the percentage of dead foliage is closely correlated with yield.

TABLE 10.—Number of adult flea beetle feeding punctures per 1.5 centimeters of leaf disc, McGuffey, Ohio

Treatment	Year and number of flea beetle feeding punctures*			
	1939	1940	1941	1942
Bordeaux	9.3	5.6	9.4	2.6
Bordeaux plus calcium arsenate	9.3	5.1	10.0	2.7
COC-S plus derris	....	....	....	3.0
COC-S plus pyrethrum	....	....	....	2.9
Untreated	....	....	44.4	20.5

*Figures are the means of 5 replications, 20-leaf samples per replicate.

DISCUSSION

During the past 9 years, bordeaux-sprayed plots have shown an average yield of 421 bushels per acre; unsprayed plots, only 313 bushels per acre. The difference, 108 bushels, represented an increase of 35 per cent due to the degree of insect and disease control that was obtained by treatment. Modifications of the bordeaux formula as to the copper-lime ratio have not resulted in significant differences in leafhopper populations, in disease control, or in yield (tables 3, 4, 5, 6, 7, 8, 9). Varying the concentration of the bordeaux formula to apply the greater part of the copper early or late in the season showed no real advantage over the regular schedule (tables 3, 4).

TABLE 11.—Simple coefficients of correlation among the variables shown, based on the means of five replicates of the several treatments

Year	Nymphs and yield	Dead foliage and yield	Nymphs and dead foliage
1936	−0.60	−0.91	0.91
1937	....	− .66	....
1938	− .73	− .81	.91
1939	....	− .49	....
1941	− .81	− .77	.83
1942	− .93	− .67	.58

The addition of calcium arsenate to bordeaux mixture and a fixed copper dust did not result in significantly larger yields than those obtained when these materials were used alone (tables 6, 7, 8, 9). Reduction in adult feeding punctures was equally good for bordeaux mixture and bordeaux mixture plus calcium arsenate (table 10).

Copper-lime dust applied only when the plants were wet with dew gave results comparable to those obtained by spraying with bordeaux mixture (tables 1, 2, 3, 4, 5, 6, 7, 8). The total copper (calculated as the metallic equivalent) applied per acre per season was approximately the same for all the copper-containing treatments.

The addition of derris and pyrethrum to sulfur compounds was of little benefit (tables 1, 2, 6, 7, 8, 9).

Sulfur dust gave excellent control of the potato leafhopper, but the yields were significantly lower than those obtained with bordeaux mixture in all except 1 of the 6 years tested (tables 2, 3, 4, 5, 6). The poor degree of foliage protection, in view of the low leafhopper populations and the absence of leaf diseases, strongly indicate that sulfur may be injurious to the foliage. The addition of sulfur to bordeaux mixture and to copper-lime dust was of no benefit; in fact, a lowering of the degree of foliage protection indicated a harmful effect by the sulfur (tables 5, 6). The addition of derris and pyrethrum to sulfur or a fixed copper was of little value (tables 1, 2, 6, 7, 8, 9). Hydrated lime applied as a spray had little effect in reducing the leafhopper population, and the vines died as quickly as those in the untreated plots (tables 5, 6). Pyrax ABB dusted on the foliage was equally ineffective (table 9).

Several fixed copper compounds gave yields comparable to those obtained with bordeaux mixture (tables 5, 6, 7, 8, 9). Of those tested, the chlorides gave better leafhopper control and yields than a basic sulfate and an oxide. In general, the fixed coppers appeared to be more effective as dusts than as sprays in these experiments. The addition of sulfur, of pyrethrum, and of derris to COC-S did not give an increase in yield over the fixed copper used alone (tables 8, 9). Various stickers included in a fixed copper spray formula were of little benefit. Several different diluents were used with fixed coppers in dust formulas, but no one was outstanding.

CONCLUSIONS

Data obtained in these experiments are presented to show: that modifications of the bordeaux formula as to the copper-lime ratio did not result in significant differences in leafhopper populations, in disease control, or in yield; that the addition of calcium arsenate to bordeaux mixture and to a fixed copper dust was of no significant benefit; that copper-lime dust properly applied gave results comparable to those obtained with bordeaux mixture; that sulfur, both as a spray and as a dust, gave excellent control of the potato leafhopper, but that the yields were significantly lower than those obtained with bordeaux mixture; that hydrated lime applied as a spray and talc as a dust had little effect in reducing the leafhopper population or in increasing the yield; that the addition of pyrethrum and of derris to sulfur and to a fixed copper was of little benefit; that several fixed copper compounds gave results comparable to those obtained with bordeaux mixture, and that the chlorides were more effective than a basic sulfate or an oxide; that the addition of sulfur to various fixed copper compounds was of doubtful value.

FEED SALES IN OHIO

J. I. FALCONER

A report of feed sales in Ohio has been received annually since 1929 from feed manufacturers by the Department of Rural Economics. A comparison of these sales for 1942 with those of 1941 and earlier years is given in table 1. Total feed sales for 1942 exceeded those of 1941 by more than 11 per cent. It is interesting to note that while sales of mixed feeds increased by 22 per cent, those of unmixed feed showed a slight decline.

TABLE 1.—Estimated total tons of commercial feeds reaching the retail trade in Ohio

Feed	Estimated tons					
	1929	1932	1937	1940	1941	1942*
Mixed feeds:						
Dairy feeds	128,320	25,214	73,030	84,767	99,474	117,797
Poultry feeds	189,139	56,805	145,885	173,536	204,044	248,730
Hog feeds	36,758	2,898	42,946	48,123	61,963	85,373
Other mixed feeds	24,728	13,332	23,904	30,623	35,927	38,208
Total mixed feeds	378,945	98,249	285,765	337,049	401,408	490,108
Unmixed feeds:						
Soybean meal	....	....	22,297	70,900	77,657	68,082
Cottonseed meal	16,708	6,666	11,461	7,104	8,805	10,525
Linseed oil meal	24,060	17,099	10,254	21,126	38,120	41,745
Bran	59,167	55,066	40,493	45,159	48,876	50,298
Middlings	56,431	42,024	52,966	53,020	49,961	52,169
Alfalfa meal	4,762	5,507	4,349	5,534	5,579	5,478
Gluten feeds	20,257	15,650	14,949	20,712	23,168	26,550
Hominy	49,775	11,303	12,443	23,086	30,806	29,531
Tankage	8,971	10,434	12,910	10,248	10,451	8,146
Meat scraps	12,154	17,389	25,154	14,878	14,084	12,756
Fish meal	....	....	817	1,469	1,526	1,389
Milk products	1,736	1,739	3,984	2,928	3,512	3,504
Other	35,367	8,695	31,946	36,982	41,571	43,134
Total unmixed feeds	289,388	191,572	244,023	313,146	354,116	353,307
Total (all feeds)	668,333	289,821	529,788	650,195	755,524	843,415

*Preliminary.

TABLE 2.—Annual feed sales in Ohio

Year	Total tonnage	Year	Total tonnage
1929	668,333	1936	514,553
1930	566,079	1937	529,788
1931	410,104	1938	570,179
1932	289,821	1939	598,785
1933	369,591	1940	650,195
1934	371,439	1941	755,524
1935	410,737	1942	843,415

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

In April 1943, Ohio farm prices reached an index of 190, compared with 210 at the close of the last war in 1918 and a high of 242 in June 1920. From March 1942 to March 1943, Ohio farm land advanced in price by 9 per cent.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	....	101	101	104	100	105	101
1914	99	....	100	101	102	102	105	109
1915	102	....	105	98	103	107	106	112
1916	125	....	124	118	113	113	121	123
1917	172	....	149	175	140	119	182	201
1918	192	....	176	202	175	131	203	243
1919	202	....	202	213	204	135	218	270
1920	225	....	201	211	236	159	212	230
1921	142	....	152	125	164	134	132	134
1922	141	....	149	132	145	124	127	133
1923	147	....	152	142	160	122	134	147
1924	143	....	152	143	165	118	133	150
1925	151	....	156	156	165	110	159	180
1926	146	....	155	145	170	105	155	183
1927	139	....	153	139	173	99	147	171
1928	141	....	155	149	169	96	154	163
1929	139	....	154	146	169	94	151	172
1930	126	....	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	140
1939	113	103	121	93	117	76	95	140
1940	114	117	122	98	116	77	99	146
1941	127	170	131	122	138	80	121	185
1942	144	227	154	157	173	89	157	244
1942								
January	140	192	146	149	153	....	141	201
February	141	199	147	145	....	....	144	183
March	142	208	150	146	....	89	146	208
April	144	210	151	150	167	....	153	230
May	144	216	152	152	....	....	157	241
June	144	222	152	151	176	......	157	232
July	144	230	152	154	179	....	159	237
August	145	233	152	163	....	....	164	248
September	145	237	153	163	....	....	161	268
October	145	249	154	169	193	....	165	290
November	146	258	155	169	....	......	167	293
December	147	267	156	178	....	....	169	297
1943								
January	149	268	158	182	196	....	174	283
February	149	276	160	178	....	....	177	261
March	150	....	161	182	....	97	181	287
April	151	....	162	185	212	....	190	....

*SOURCE: Bureau of Business Research, The Ohio State University.

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OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO, U.S.A.

YOUR AUTHORS

The prevalence of disease and insect pests has much to do with the production of good yields and good quality in wheat. J. S. Houser, Chief of the Entomology Department, and H. C. Young, Chief of the Department of Botany and Plant Pathology, in this issue indicate the infestations this year, emphasize again the safe seeding dates to avoid the Hessian fly, and discuss the situation with regard to wheat scab, as well as other diseases and insect pests.

Houser

Young

Stem rust is one of the most destructive diseases of wheat, oats, barley, and rye in this country. Harry Atwood, of the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, and State leader of barberry eradication, and R. C. Thomas, Ohio Agricultural Experiment Station plant disease specialist, give details of the nature of the disease and its spread and indicate the progress of the eradication program to remove barberry bushes, potential sources of stem rust every year.

Atwood

Thomas

How have people adjusted to every-other-day delivery of milk in cities of Ohio? C. G. McBride, rural economist of the Ohio Agricultural Experiment Station, discusses the information on this question secured from surveys in three Ohio cities, representative of a range of employment conditions.

McBride

Other authors in this issue, who are already familiar to Bimonthly Bulletin readers, include: W. L. Robison, swine specialist, D. C. Kennard and V. D. Chamberlin, poultry specialists, Alex Laurie, flower specialist, who collaborates with Elinor Johnson in an article in this issue, and J. I. Falconer, Chief of the Department of Rural Economics and Rural Sociology.

At the request of the Office of War Information, publications this month salute women in war work. America salutes her women in the military and Red Cross Services, her women in the factory and on the farm. Due for recognition, too, are America's women in the research laboratories of the Nation. Our "cover girl" in the parade of women at war work is Beth Pascoe, assistant chemist in the Federal Soft Wheat Laboratory, at the Ohio Agricultural Experiment Station.

IN THIS ISSUE

THE WHEAT FIELD SURVEY FOR 1943

J. S. HOUSER AND H. C. YOUNG

Because of the importance of the wheat crop under wartime conditions, it was decided by the entomologists of The Ohio Agricultural Experiment Station, The State Department of Agriculture, and The Ohio State University to continue the wheat field survey project this season. Critical records were taken in 21 of the principal wheat-growing counties of the State, and, in addition, similar data were collected in 12 additional counties by the Federal Bureau of Entomology and Plant Quarantine.

For the most part, the record for each county was based on samples taken from each of 10 fields selected at random. In a few counties only, fewer than 10 fields were sampled.

Particular attention was given to Hessian fly because this insect is the most serious wheat pest in Ohio. In addition, notes were taken on joint worm, black wheat-stem sawfly, chinch bugs, and wheat straw worm.

Finally, a statement is included in this report concerning wheat scab, which was abnormally severe this year, particularly in the western and southwestern parts of the State.

HESSIAN FLY

We are happy to report that Hessian fly was found to be much less prevalent in Ohio this season than in 1942. The average infestation of all the counties surveyed last year was 25.7 per cent, whereas this year the average for the State is 4.3 per cent. Last year Warren County ranked highest in Hessian fly with an average infestation of 52 per cent. This year, Carroll is highest with an average infestation of 28 per cent. The record of Hessian fly infestation in the counties surveyed is shown in figure 1.

Wheat growers should not develop a false sense of security with respect to Hessian fly because the infestation is low this season. During the 26 years the Hessian fly survey has been made in Ohio, there have been 4 years when the average infestation was as low as, or lower than, for 1943. These are:

1918	1.0 per cent
1923	4.3 per cent
1937	4.3 per cent
1940	4.0 per cent

In every instance in the past when Hessian fly infestation has been low, there has been a sharp increase in abundance the following year. For example, in 1918, when the average infestation of the State was the lowest on record, 1.0 per cent, the year following the average infestation increased to 14.4 per cent and the next year it rose to 44 per cent, which is the highest of the 26-year record.

In view of the foregoing experiences of wheat growers in Ohio and because of the strategic importance of the wheat crop in wartime economy, it would seem particularly advisable that wheat growers conform this fall to the safe-sowing dates. These dates have been determined through years of study and experience and have been proven to be surprisingly dependable from the standpoint of escaping damage from Hessian fly, especially if all the wheat growers in a community delay seeding until the approved date. On the other hand, a few early-sown fields can pollute the entire neighborhood.

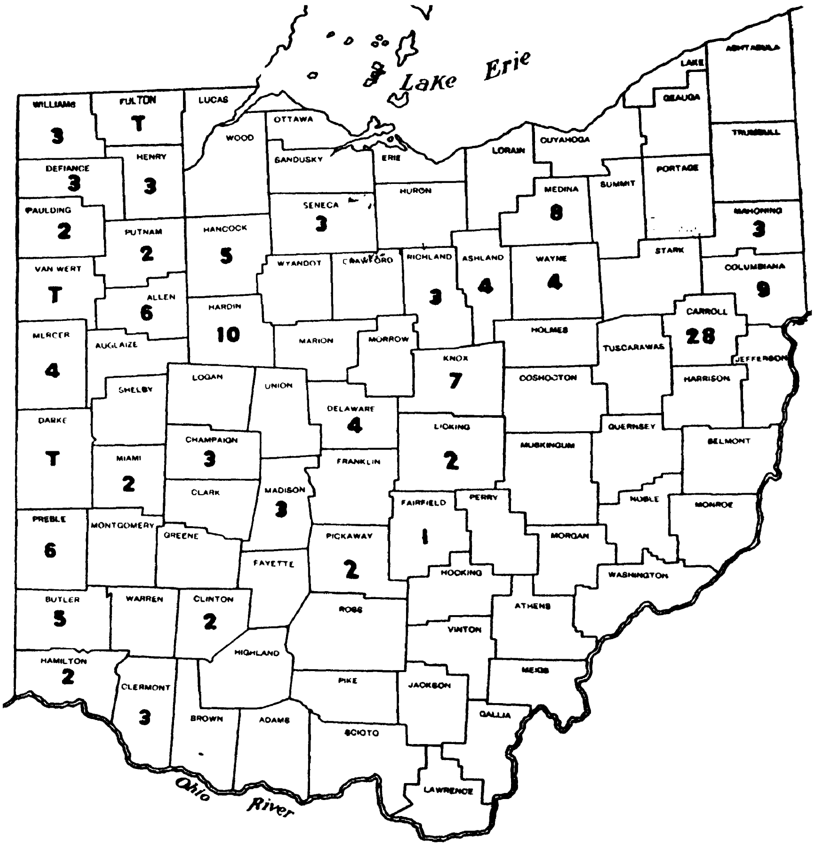

Fig. 1.—Figures indicate the percentage of wheat straws infested with Hessian fly in the counties visited in the 1943 survey.

Average infestation for 1942, 25.7 per cent
Average infestation for 1943, 4.3 per cent

Moreover, the seeding dates that are safe from the standpoint of avoiding damage from Hessian fly have been found by the agronomists to be best from the standpoint of yield. That is to say, wheat sown much earlier may become too rank before the advent of cold weather. On the other hand, if wheat is sown much later than the fly-free date it may not become sufficiently established to withstand the rigors of winter.

The safe-sowing dates for Ohio are shown in figure 2.

OTHER INSECT PESTS OF WHEAT

The black wheat-stem sawfly, which was discovered in eastern Ohio in 1934, became destructively abundant in 1936, principally in Mahoning, Columbiana, and Carroll Counties.

During the intervening years since 1936 the insect has gradually spread westward until this year it was recorded in Richland County. Meantime, however, the outbreak seems to have spent itself until now the black wheat-stem sawfly is no longer a serious threat. In 1936 the average infestation of the wheat in Mahoning County was 65 per cent; in Columbiana County, 68 per cent; and in Carroll County it was also 68 per cent. The highest infestations found this year were: Ashland County, 5.6 per cent; Columbiana County, 4.8 per cent; Richland County, 4.7 per cent; and Medina County, 4.4 per cent. Mahoning and Carroll Counties, which were so severely damaged in 1936, were found to be only 1.6 per cent and 2.0 per cent infested, respectively.

Neither of the two species of wheat joint worm was found in disturbing numbers in any part of the State, and in a few fields only were any traces of chinch bugs found.

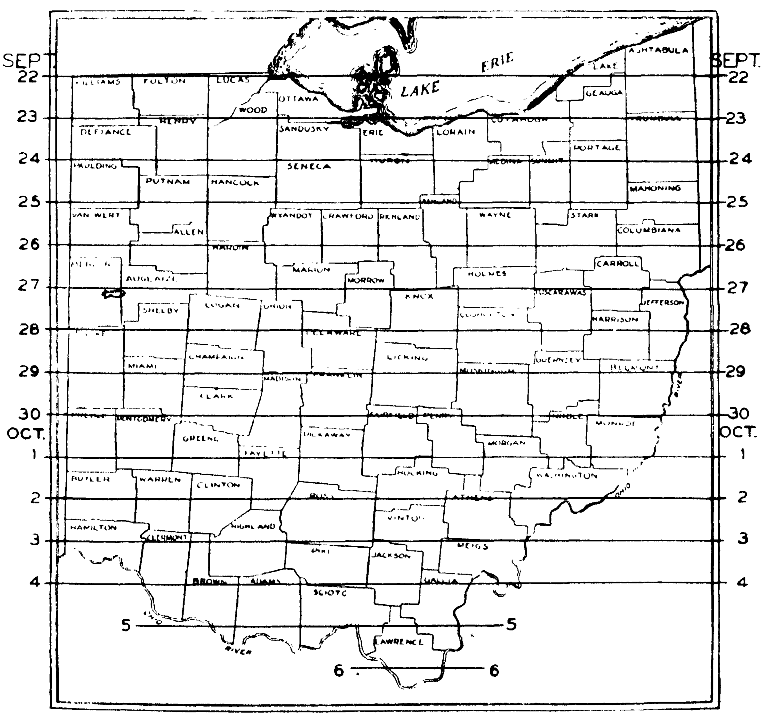

Fig. 2.—Hessian fly safe-sowing dates

WHEAT SCAB

Although it was not possible this year to take specific records on damage from wheat diseases, a general survey of the wheat fields of the State indicated that losses from scab reached serious proportions. The disease was most damaging in the western and southwestern parts of the State, though considerable loss occurred throughout. These losses ranged between 3 to 5 per cent and 50 to 60 per cent, with a general average of 15 to 20 per cent.

The chief loss to the wheat crop due to scab is completely blasted heads and shrivelled grain. While much of the shrivelled and deformed wheat is removed by cleaning, there still remains a high percentage of the diseased grains; perhaps one end consisting of half or more of the grain will remain plump, the other half being shrivelled and diseased. Such grains are not readily separated out either by the wind or screen. This is the reason why scab-infected wheat is light. Much of the grain from the heavily infected fields that is now being brought to market weighs only 42 to 50 pounds per bushel.

The most noticeable symptom of wheat scab is the blasted appearance of a portion or all of the head. In severe cases, such as occurred this season, the fields seem to ripen very rapidly or, as is often remarked, "over night." These symptoms are more readily observed in brown-chaff varieties than on white-chaff, but this characteristic does not signify that one is more susceptible than the other. There seems to be no variety of wheat that is immune to scab, and, of the commercial varieties, all seem to be about equally susceptible.

Scab of wheat, barley, and oats is caused by a fungus parasite. This same fungus causes a root rot of corn. The belief has prevailed for many years that wheat sown after corn will have more scab. In general, this is true, although scab is not confined to wheat following corn.

Scab infects wheat at the blooming stage. A prolonged wet period just ahead of and during bloom is very favorable for infection. The fungus lives over the winter mostly on old corn stalks and perhaps on other partially decayed organic material. The spores of the fungus may mature over quite a long period in the spring. The wheat, however, is only susceptible during the bloom period. Since it requires a rainy period to mature a crop of the fungus spores, it is only during such a period that infection can take place.

There is no definite control yet developed. When corn ground is sown to wheat, it sometimes helps to plow or disk under all of the corn stalks, although, in favorable seasons, this procedure is of little value. Apparently, the spores are widespread and may be blown about quite generally. The disease seems to be increasing from year to year and must now be placed in the class of serious pests of wheat.

The loss due to scab is not confined to the reduction in yields. Diseased wheat loses much of its nutritive value and is reported to be poisonous to hogs. Results of tests conducted by the Dairy Department of the Experiment Station indicate that scabby wheat is safe for other types of animals and the feeding value, on a weight basis, is equal to other grains.

Wheat seriously infected with scab should not be used for seed, as not all of the diseased grains can be cleaned out. When such grains germinate they produce a weak seedling that ordinarily does not survive the winter. In general, seed wheat from this year's crop should be thoroughly cleaned and treated with a standard seed-treating material.

ERADICATION OF THREE AND A HALF MILLION BARBERRY BUSHES PROTECTS OHIO GRAIN FROM STEM RUST

HARRY ATWOOD[1] AND R. C. THOMAS

Stem rust is one of the most destructive diseases of wheat, oats, barley, and rye in the United States. When it develops to epidemic proportions hundreds of millions of bushels of these grains are destroyed in a single year. For the period 1916-1927, the average annual loss amounted to 55 million bushels in 13 of the important grain-producing states, including Ohio. During the next 12-year period, 1928-1939, the loss was reduced by approximately 50 per cent. In Ohio alone during this period the average annual loss was reduced from 7,500,000 bushels to less than 4,000,000. This reduction was due primarily to the eradication of rust-spreading barberry bushes, the more general use of rust-resistant varieties of grain, and improved cultural practices.

In Ohio rust-susceptible barberry bushes are potential early sources of stem rust every year. Stem rust causes reduced crop yields and poor-quality grain, with consequent sharp discount by buyers. This loss occurs after the principal costs of production have been incurred. Since some small grain is grown on practically every farm in Ohio, the control of this disease is of interest to every farmer.

The protection of the small-grain crops against loss from stem rust by the eradication of rust-spreading barberry bushes is a direct aid in the production of meat, eggs, milk, and other foods so urgently needed now by our fighting forces.

In 1916, just before the United States entered the first World War, surpluses of small grains were eliminated as a result of severe losses due to stem rust, and flour and other cereal products had to be rationed. That year a widespread stem-rust epidemic caused a loss of $284,000,000 to wheat alone in 13 of the North-Central States now engaged in barberry eradication. In many communities where bushes were numerous, complete crop failures were common. The destruction of more than 300 million barberry bushes since 1918 has prevented many of these local epidemics and consequent losses to growers and the industries dependent on small-grain crops.

THE NATURE OF THE DISEASE

Stem rust is caused by a fungus that lives in the Northern States on rust-susceptible barberry bushes and on grains and wild grasses. The rust is spread between host plants by wind-borne spores. It survives the winter in the black-spore stage on grain stubble, in straw piles, and on wild grasses. These spores cannot attack new crops of grains and grasses in the spring but they infect susceptible barberry bushes, and the spring stage of the rust develops on the leaves. The rust spores from diseased barberry leaves infect nearby wild grasses and grain plants, and the red or summer stage of the disease develops on these plants. Once this stage becomes established in grain fields, the rust spreads by

[1]Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture, State Leader of Barberry Eradication, stationed at Columbus, Ohio.

means of wind-blown spores from plant to plant and from field to field over extensive areas. When weather and crop conditions are favorable, these local epidemics merge and cause regional epidemics of great destructive power. As the grain reaches maturity, the overwintering or black-spore stage forms on the ripened straw and grasses.

The annual life cycle of the stem rust is shown in the drawing of figure 1. Figure 2 shows the identifying characteristics of the common barberry, the one on which the stem rust spores are developed.

The eradication of barberry bushes eliminates the early spring stage in the life cycle of the fungus and thus prevents local outbreaks of this disease in important grain-producing areas. There are on record more than 100 cases in 42 Ohio counties in which local stem rust epidemics were traced directly to rust-spreading barberry. In some individual cases complete crop failures were common and crops were affected within a radius of 4 or 5 miles of the barberry bushes. Eradication of the bushes resulted in the complete elimination of those local epidemics.

Development of new races of stem rust on barberry bushes.—The eradication of rust-susceptible barberry bushes has another important value

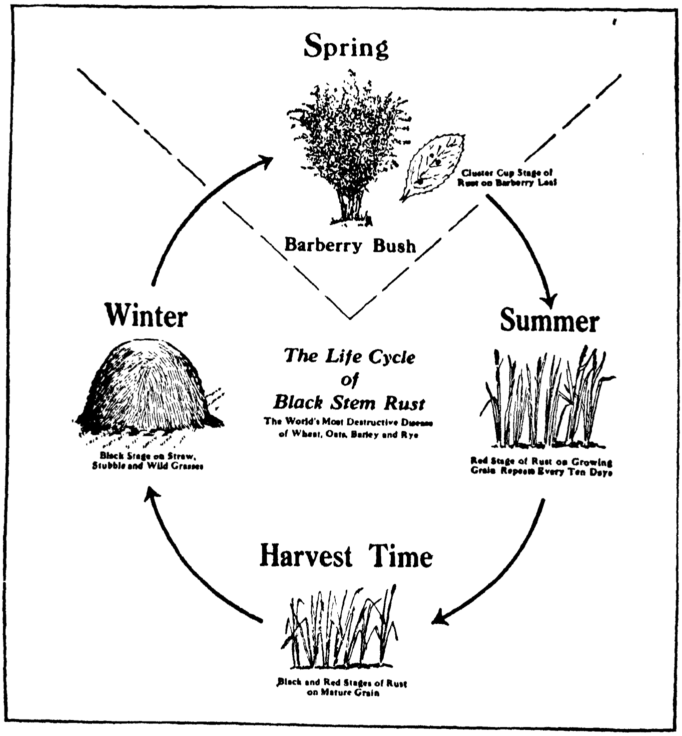

Fig. 1.—Principal stages in the life cycle of the black stem rust

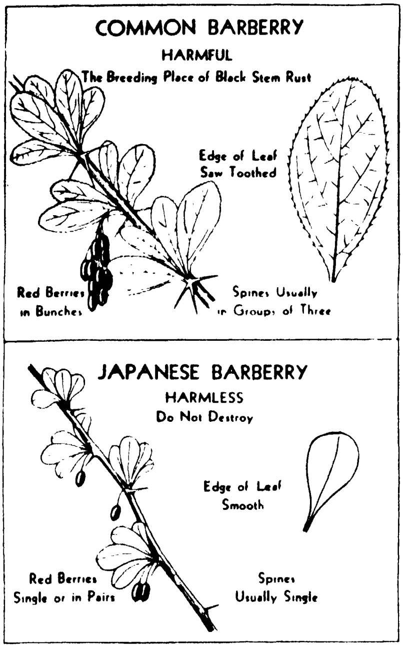

Fig. 2.—Identifying characteristics of the common barberry.

to grain producers and dependent industries. Just as there are many varieties of wheat, oats, barley, and rye, there likewise are many varieties and races of the stem rust fungus. Certain varieties of grain are highly resistant to some of these races but are very susceptible to others. New races are produced and old ones perpetuated on the leaves of barberry bushes. Thus the eradication of the barberry reduces the opportunity for the fungus to develop new races that may be capable of attacking new and improved resistant varieties of grain.

Another source of stem rust.—In the Central States there is another source of rust epidemics. Under favorable conditions the fungus overwinters on grains and grasses in northern Mexico and Texas, where the winters are mild. Grain fields are almost continuous from Mexico to southern Canada. In the South these crops mature early and ripen progressively as the season advances northward. Some years, when moisture, temperature, and crop conditions are favorable, the red stage of the rust increases on the grain in the South, producing billions of spores. These spores are carried northward hundreds of miles by the wind and infect the developing grain. The spores produced on the newly infected grain are swept farther north by the wind, and in this manner the rust may build up into a major epidemic. Wind, moisture, temperature, and the condition of the grain must all be favorable at the right time to enable such epidemics to develop. Although it is possible for an epidemic to develop in Ohio from wind-borne rust spores from the South, losses caused by rust from this source have been of no consequence during the past 25 years.

All methods of control necessary.—In 1935, again in 1937, and to a lesser extent in 1938, widespread epidemics of stem rust occurred in the Mississippi Valley. In these years the severely rusted fields of grain in the South and barberry bushes growing in the important grain-producing areas provided an abundance of rust. This, combined with favorable weather and crop conditions, resulted in widespread damage from stem rust. Such epidemics as these, while infrequent, clearly demonstrate that the control of stem rust is a problem of national importance. It involves the protection of the nation's basic food crops of wheat, oats, barley, and rye, and advantage should be taken of all available facilities contributing toward potential losses from the disease.

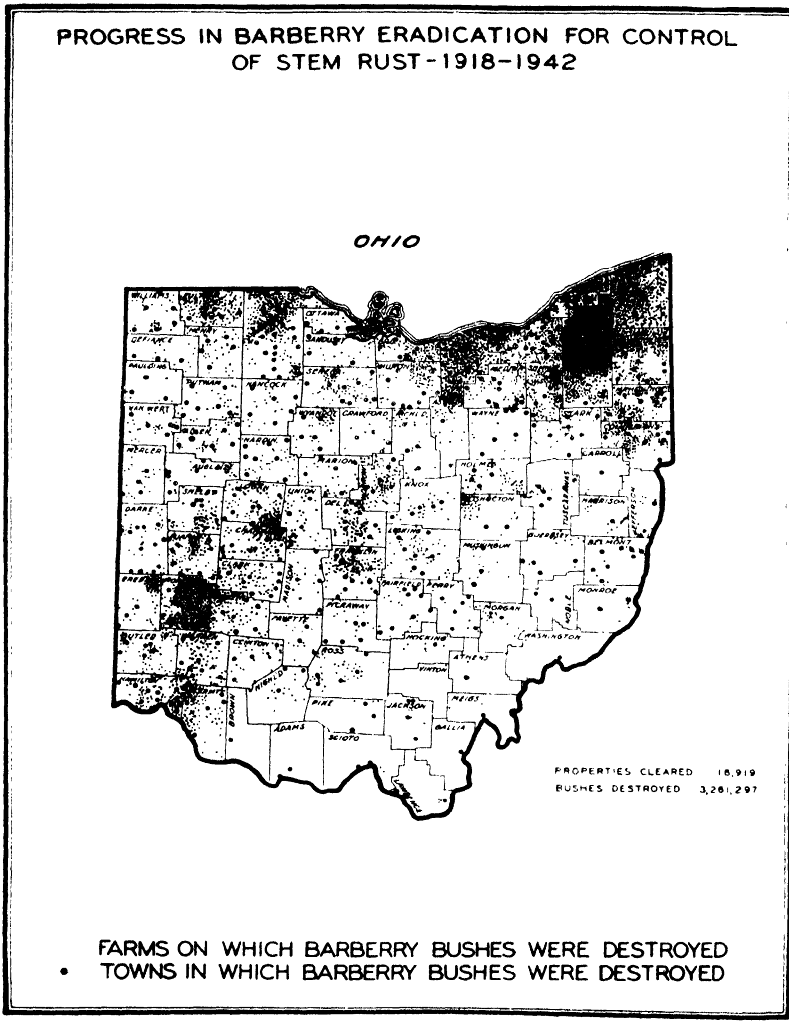
PROGRESS IN BARBERRY ERADICATION FOR CONTROL
OF STEM RUST-1918-1942
OHIO
PROPERTIES CLEARED 16.919
BUSHES DESTROYED 3,261,297
FARMS ON WHICH BARBERRY BUSHES WERE DESTROYED
• TOWNS IN WHICH BARBERRY BUSHES WERE DESTROYED

Fig. 3

Rust from the South may be greatly reduced by growing only improved rust-resistant varieties of grain in the southern part of the wheat belt. This would limit the amount of rust overwintering and the local build-up of spores on these early grain crops. The control of stem rust therefore requires, in addition to the eradication of susceptible barberry plants, the use of seed from improved resistant varieties of grain and the early sowing of spring grains. All these measures are necessary to obtain effective control of rust in the United States.

PROGRESS OF THE ERADICATION PROGRAM IN OHIO

Barberry eradication in Ohio is administered by the Bureau of Entomology and Plant Quarantine, of the United States Department of Agriculture. The program has been in operation continuously in cooperation with the Ohio State Department of Agriculture and the College of Agriculture since 1918. Substantial progress has been made in the destruction of this plant pest. This was particularly true during the period when emergency relief funds were available to employ labor for the control operations. The substantial reduction in the occurrence of local epidemics and the resultant reduction in annual stem rust losses in Ohio have been due largely to the destruction of the 3,262,000 barberry bushes on 17,000 properties. More than 30,900 square miles, or about three-quarters of the State, have been given an intensive survey. Barberry bushes have been found in every Ohio county.

The map in figure 3 shows the areas in Ohio that have been cleared of barberry bushes.

The immediate problem.—There are many parts of the State where the initial survey has not been completed and where barberry bushes are still growing. Of most importance, however, is the fact that some regrowth is occurring in areas where plants have been destroyed, and reinfestation will take place if the bushes are not kept suppressed in these areas. To protect the work already done, areas that were originally heavily infested must be rechecked periodically until there is no further danger of regrowth. In 80 of the 88 counties in Ohio barberry bushes had escaped from cultivation and produced seed for years before they were destroyed. Several inspections at intervals of 5 to 7 years of many of these areas will be necessary to assure the complete elimination of the bushes.

The map in figure 3 shows the areas in Ohio that have been cleared of barberry bushes.

Barberry bushes can be destroyed by digging, if care is taken to get out all roots, but the application of salt at the crown of each plant is the most satisfactory and recommended method of eradication. Property owners and occupants can contribute to this program by reporting new locations of barberry to county agricultural agents or to the Barberry Eradication Office, Post Office Box 746, Columbus, Ohio.

FLOWER INITIATION AND DEVELOPMENT IN THE ORCHID *CATTLEYA PINOLE*

ELINOR JOHNSON AND ALEX LAURIE

Comparatively little research work has been done in orchid culture. Certain practices have been carried on and have become more or less established as the correct methods in the culture of orchids. Until recent years, however, scientific experimentation to determine the cultural practices that would produce the optimum of growth and flower production had not been carried on. During the past 3 years at The Ohio State University research has been conducted to determine the effects of light intensity, photoperiodism, acidity of the water, humidity, and nutrients on the growth rate and flower production of commercial orchid varieties. The results of these studies have indicated that significant variations in both growth and flower production may be secured by manipulation of the environmental factors.

With the increasing knowledge of the direct effects of different cultural practices, the need arose for definite information as to the time of flower initiation in the shoot and the rate of development of the flowers. Such information would be a basis for further research to determine the direct effect of varying a specific environmental factor on the subsequent initiation and development of the floral primordia. For example, it was found that those plots given nutrient solution and those subjected to greater light intensities during daylight hours increased in flower production from 1.08 flowers per plant to 2.75 flowers per plant, and from 0.5 to 1.5 flowers per plant, respectively.[1]

Obviously the treatment given could be much more intelligently applied if the grower knew during which period of growth the buds were formed. If flower primordia (those primordial parts which develop into the flowers) were formed while the shoot was still a dormant bud, that would be the critical period for close supervision of the environmental factors. If, however, they were formed after the shoot had reached maturity, it would be useless to regulate conditions while the shoots were dormant and neglect them when the shoots neared maturity. The present study was carried out to determine the stage of shoot development at which flowers are initiated and to trace their morphological development to anthesis (the stage of full bloom of the flower).

The variety used in this study was *Cattleya pinole*. Shoots were taken in all stages of growth, from the dormant shoot bud to the matured shoot, in consecutive centimeter lengths, as dormant bud, one centimeter long, two centimeters, etc. The total shoot length was measured inclusive of leaf blade and leaf sheath. The upper one-half to one centimeter section of the apex of the shoot was severed, killed, and then fixed in Universal fixative. The sections were imbedded by Johansen's paraffin method. Microtoming was done at 10-12 microns in thickness and the sections stained by the safranin-fast green method.

While the evidence did not establish a definite shoot length for the initiation of floral primordia, it did

[1]Plants used in these tests were young plants just beginning to produce; so all averages are low, but the differences produced are significant.

Fig. 1.—An early stage in shoot development. Note the rounded apex of the bud and the leaf sheaths that enclose it.
L, leaf sheath; A, apex of shoot.

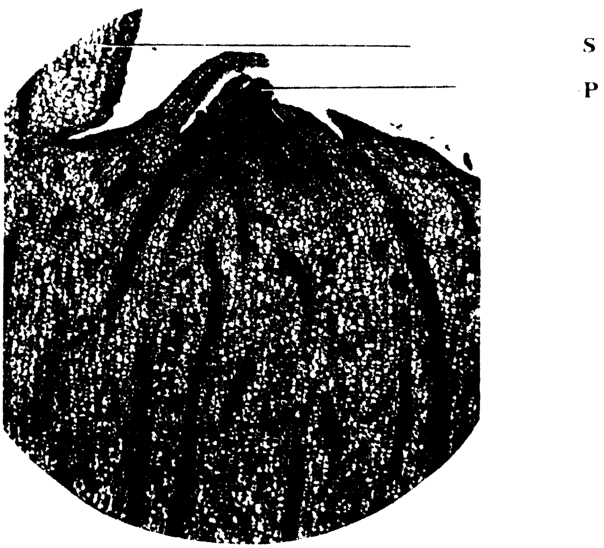

Fig. 2.—Section from a shoot 12 cm. long. The apex has become conic in form and definite primordia are forming.
S, flower sheath; P, flower primordium.

establish a range in lengths in which the initiation occurred in *Cattleya pinole*.

The apical meristem or shoot tip was broad and shallow with no evidence of protuberances on the margin. In all dormant buds the apex had the same general appearance as illustrated in figure 1. There was no change in the appearance of the primordium from dormant bud to a shoot length of 8 centimeters. At a length of 8 centimeters the apex had become conic in form with indications of a protuberance arising. At 12 centimeters the change in form of the shoot apex was more apparent, but flower parts were not yet discernible, as seen in figure 2. Between a length of 12 and 18 centimeters the flower primordia are initiated. There was evidence of some latitude in time of initiation. Primordia in some shoots 17 centimeters long were more advanced in development than other primordia from mature shoots. Figure 3 indicates the beginning of distinct flower bud formation. Figure 4 is from a section of a mature shoot. The various flower parts have formed and their nearly equal size would indicate nearly simultaneous development. Flower parts appeared to be laid down in the order sepals, petals, stamens, and pistil (stigma). The stigma developed more slowly and appeared in longitudinal section as a small lobe closely appressed to the column. By the time a flower bud has reached a length of 2 millimeters all flower parts are distinct. Sepals and petals are incurved above the column. The tip of the column has begun to expand where pollen mother cells are subsequently to develop; the stalk of the column remains short. When the flower bud is 3 millimeters long, the column has become differentiated and the tip or cap of the column, pollen-forming tissue, and rostellum (the barrier of tissue separating the pollen masses and the stigmatic surfaces) are distinct. Figure 4 is of a section of a flower bud 2 millimeters in length, showing the great amount of differentiation that has occurred. This section is also of interest as it shows distinctly that abortion of the upper two buds has occurred in this early stage of development.

At a bud length of 11 millimeters the stigmatic lobe has become contiguous with the column and stigma, and enclosing the inner surfaces of the two to form an open channel to the ovulary. The inner surfaces of the ovulary develop three parietal placentae, and numerous undifferentiated ovules develop from the surface cells. Figure 5 is of a section from a bud 11 millimeters long.

During the last stages of development all parts elongate rapidly and there is rapid elongation of the ovulary. At the time of anthesis or full bloom, the tissues of the ovulary wall are stimulated to uneven growth in such a way as to cause a torsion of 180 degrees so that the labellum, which is really the uppermost petal, becomes the lower petal of the flower.

A record was kept of the rate of growth of individual shoots, from the time growth began up to the appearance of the flower sheath. It took approximately one month for a dormant *Cattleya pinole* shoot to attain a length of 8 centimeters, and another three weeks to reach 18 centimeters in length. The first month's growth is, roughly, the critical stage which will determine whether the shoot will flower, and the next month will determine the number and quality of the flowers. The rate of shoot growth would vary greatly with locality, season, and growing conditions in the house, but,

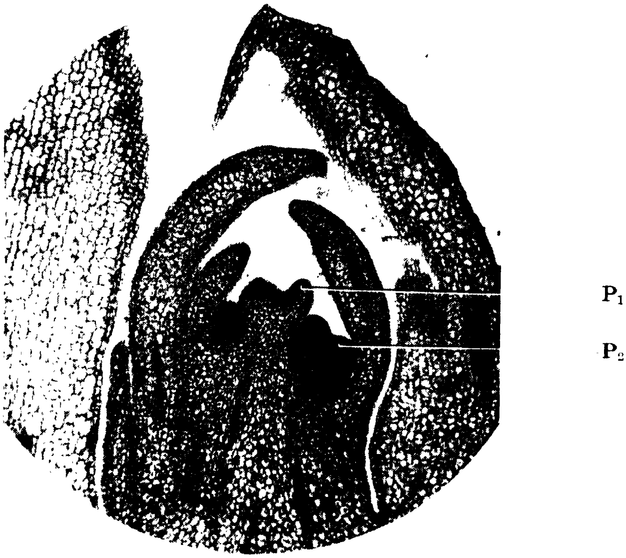

Fig. 3.—Section from a shoot 17 cm. long with flower parts being laid down. First to arise were the sepals. P_1 and P_2 are flower primordia with flower parts differentiating.

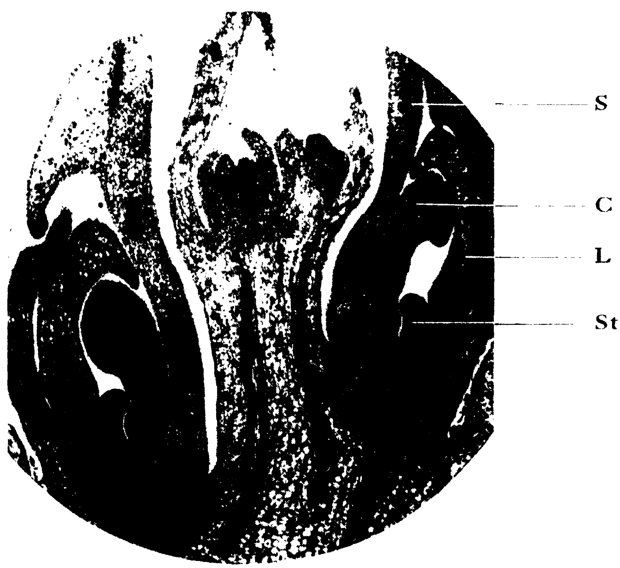

Fig. 4.—Section from a mature shoot. Total length of the flower bud is 2 mm. S, sepal; C, column; St, rudimentary stigma; L, labellum or lip.

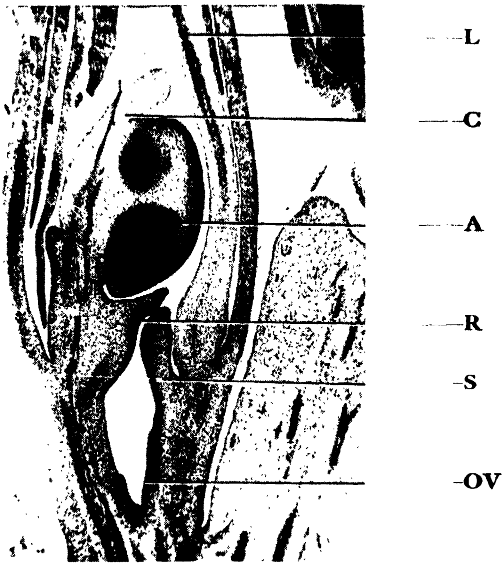

Fig. 5.—Section of flower bud 8 mm. long. A, anther; C, anther cap; R, rostellum; S, stigma; L, labellum; OV, placental tissue of the ovulary.

in general, the first 6 weeks of shoot growth are perhaps the most critical in determining flower production. It is during these initial stages that the grower would like to know whether cool or warm temperatures, whether high or low light intensity, or whether increased nutrient supplies are more favorable to flower initiation. Further research is necessary to confirm and amplify the results of these studies.

SUMMARY

In *Cattleya pinole* flower bud formation does not occur in shoots less than 8 centimeters long.

Between a length of 12 centimeters and 18 centimeters the flower primordia are formed, and flower parts begin to form.

Flower parts are all distinct when the flower bud is 2 millimeters long. This section is also of interest as it indicates that abortion of the upper two buds may have occurred in this early stage of development.

The first month's growth is the critical stage which determines whether the shoot may flower.

The second month's growth is the period of flower bud initiation and will determine the number of flower buds formed.

FAT IN RATIONS FOR SWINE

W. L. ROBISON

Feeds vary in the amount of fat or oil they contain. Fats and oils are similar except that fats are solid and oils are liquid at ordinary temperatures. Both are soluble in ether. In feed analyses the material dissolved out with ether is classified as ether extract or fat. In this report the words fats and oils are used interchangeably. Both fats and carbohydrates are heat- and energy-producing materials. However, when they are oxidized, the fats furnish approximately 2.25 times more heat or energy a pound than do starches and sugars or the carbohydrates.

A growing and fattening animal utilizes a portion of its feed for the production of heat and energy, a portion for tissue growth and repair, and a portion for the production of fat. Pigs can convert fat, carbohydrates, and, if necessary, proteins into animal fat. The pork fat derived from carbohydrates and protein is firm at ordinary temperatures. The feed fat is converted into pork fat without being changed materially. The fats in many feeds, such as those in corn, oats, soybeans, peanuts, and rice by-products are liquid rather than solid at ordinary temperatures. If rations contain much over 4.5 per cent of such fats, there is danger of their producing a soupy rather than a firm lard and pork that the consumer dislikes because of its flabbiness and lack of firmness.

Recognizing that a pound of fat was equal in heat and energy value to 2.25 pounds of carbohydrates, hog feeders once carefully watched the minimum fat guarantee of the feeds they purchased. More recently, possibly because of the knowledge that much softening fat in the ration is likely to cause soft pork, less attention has been paid to the fat content of purchased feeds for hogs.

In 1939 and 1940 tests were carried on at the Ohio Experiment Station in which rations that were similar except that they contained different amounts of fat were fed to growing and fattening pigs. Although the primary object of the experiments was to study the influence of the rate of fat deposition on the firmness of fat in hogs, they furnish data on the effect of different levels of fat in the ration.

The rations in the 1939 experiment contained 2.6, 5 6, and 8.7 per cent of fat, respectively. All of the ingredients were fed at constant levels throughout the experiment. The grain consisted of one-third corn and two-thirds wheat, by weight. Dried skimmed milk, soybean oil meal, cottonseed meal, and ground alfalfa made up 2, 4, 3, and 4 per cent of the total feed, respectively. One per cent of minerals was included in the low-fat ration and 0.8 per cent in the other two. The low, medium, and high fat rations contained 5, 5.7, and 6.2 per cent of fish meal, and the medium and high fat rations, to alter the fat content, 3.1 and 6.2 per cent of corn oil, respectively.

Each ration was fed to two groups of pigs. To one the feed was self-fed for rapid gains. To the other, it was restricted to approximately 2.75 pounds daily per 100 pounds of live weight, for slower gains. There were

TABLE 1.—Various proportions of fat in rations for growing and fattening pigs

	1	3	5	2	4	6
	Full-fed			Limited-fed		
	Grain 81 Protein concentrate 14 Ground alfalfa 4 Minerals 1	Grain 77.4 Protein concentrate 14.7 Ground alfalfa 4.0 Minerals .8 Corn oil **3.1**	Grain 73.8 Protein concentrate 15.2 Ground alfalfa 4.0 Minerals .8 Corn oil **6.2**	Grain 81 Protein concentrate 14 Ground alfalfa 4 Minerals 1	Grain 77.4 Protein concentrate 14.7 Ground alfalfa 4.0 Minerals .8 Corn oil **3.1**	Grain 73.8 Protein concentrate 15.2 Ground alfalfa 4.0 Minerals .8 Corn oil **6.2**
Per cent fat in ration	**2.58**	**5.63**	**8.67**	**2.58**	**5.63**	**8.67**
Pigs at start	24	23	24	24	23	23
Initial weight per pig, lb.	52.8	53.1	53.0	51.7	52.2	52.0
Final weight per pig, lb.	206.7	211.9	202.6	206.3	209.1	211.1
Average daily gain, lb.	**1.34**	**1.30**	**1.32**	**.85**	**.94**	**1.03**
Days to gain 160 pounds	120	124	122	189	171	156
Daily feed per pig, lb.:						
Grain	4.15	3.77	3.30	2.70	2.65	2.49
Protein concentrate	.72	.72	.68	.47	.50	.51
Ground alfalfa	.21	.19	.18	.13	.14	.13
Minerals	.05	.04	.03	.03	.03	.03
Corn oil	....	.15	.28	....	.11	.21
Total	5.13	4.87	4.47	3.33	3.43	3.37
Feed per 100 lb. gain, lb.:						
Grain	309.08	290.88	250.68	317.58	282.63	241.46
Protein concentrate	53.42	55.24	51.62	54.89	53.67	49.73
Ground alfalfa	15.26	15.03	13.59	15.68	14.61	13.09
Minerals	3.82	3.01	2.72	3.92	2.92	2.62
Corn oil	....	11.65	21.06	....	11.32	20.28
Total	**381.58**	**375.81**	**339.67**	**392.07**	**365.15**	**327.18**
Feed per 100 pounds of gain with fat times 2.25*	393.89	402.26	376.48	404.71	390.85	362.64
Cost of feed per 100 lb. gain	$ 6.96	$ 7.66	$ 7.64	$ 7.15	$ 7.44	$ 7.36
Value of added fat per pound	....	1.99¢	4.78¢	....	5.42¢	6.98¢

Grain=ground yellow corn, 1; ground wheat, 2.

Dried skimmed milk, soybean oil meal, and cottonseed meal made up 2, 4, and 3 per cent, respectively, of the total ration. In addition to these, the protein concentrate contained fish meal. The fish meal made up 5, 5.7, and 6.2 per cent of the total feed of the low, the medium, and the high fat rations, respectively.

Minerals=salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; iron sulfate, 4.

Prices used: Corn, 1.5; wheat, 1.5; fish meal, 4.0; soybean oil meal, 2.25; cottonseed meal, 2.25; dried skimmed milk, 5.0; ground alfalfa, 1.25; minerals, 2.0; corn oil, 8.0; cocoanut oil, 8.0; grinding grains, 0.1 cent a pound.

*Multiplying the fat by 2.25 places the rations on an approximately equivalent energy basis. Differences that still exist in the feed required per unit of gain are due to something other than differences in energy value.

24 pigs to the group at the start. Two, two, and ten were removed for slaughter when their individual weights approximated 100, 150, and 200 pounds, respectively. As the remaining individuals reached a weight of approximately 250 pounds they were removed and slaughtered. At weights of approximately 100 and 150 pounds, back fat samples were taken from five pigs from each lot. When they weighed approximately 200 pounds, back fat samples were taken from all of the pigs that were carried to a weight of 250 pounds. These included the five from which fat samples were taken at the 100- and 150-pound weights.

Table 1 summarizes the feed-lot performance of the six groups. A pig which failed to gain from the start was removed from each of Lots 4 and 6. One in Lot 1 died on the 28th day. For some reason, the pigs in Lot 3 failed to perform normally at the beginning of the test. During the first 8 weeks they made less gain per unit of feed consumed than did those in Lot 1; thereafter, they did the opposite. Their poor start doubtless made their average feed requirement per unit of gain higher than it would have been other-

TABLE 2.—Effect of increasing the percentage of fat in the ration of growing and fattening pigs

	1	3	2	4
	Full-fed		Limited-fed	
	Grain 78.9 Protein concentrate 14.7 Ground alfalfa 4.0 Minerals .8 **Corn oil 1.6**	Grain 77.4 Protein concentrate 14.7 Ground alfalfa 4.0 Minerals .8 Corn oil **3**.1	Grain 78.9 Protein concentrate 14.7 Ground alfalfa 4.0 Minerals .8 **Corn oil 1.6**	Grain 77.4 Protein concentrate 14.7 Ground alfalfa 4.0 Minerals .8 **Corn oil 3**.1
Per cent fat in ration	**4.2**	**5.6**	**4.2**	**5.6**
Pigs at start	10	10	10	10
Initial weight per pig, lb.	51.8	52.1	51.3	50.2
Pigs at close	10	10	10	10
Final weight per pig, lb.	205.6	207.4	203.3	208.2
Average daily gain, lb.	**1.29**	**1.38**	**.88**	**.92**
Days to gain 160 pounds	125	116	182	174
Daily feed per pig, lb.:				
Grain	3.87	3.60	2.45	2.33
Protein concentrate	.72	.68	.46	.44
Ground alfalfa	.20	.19	.12	.12
Minerals	.04	.04	.02	.03
Corn oil	.08	.14	.05	.09
Total	4.91	4.65	3.11	3.01
Feed per 100 lb. gain, lb.:				
Grain	299.48	261.25	279.21	253.37
Protein concentrate	55.80	49.62	52.02	48.12
Ground alfalfa	15.18	13.50	14.16	13.09
Minerals	3.04	2.70	2.83	2.62
Corn oil	6.07	10.46	5.66	10.15
Total	**379.57**	**337.53**	**353.89**	**327.35**
Feed per 100 pounds of gain with fat times 2.25*	399.50	361.58	372.47	350.67
Cost of feed per 100 lb. gain	$ 7.37	$ 6.88	$ 6.87	$ 6.67
Value of added fat per pound	....	19.22¢	....	12.47¢

A solution was made by dissolving 0.1 pound of iron sulfate (copperas) in a pint of water. A pint of the solution was mixed with each 5 pounds of cottonseed meal. The meal was then allowed to stand for an hour before it was mixed with the other feed. The object of the treatment was to overcome any possible toxic effect of the cottonseed meal.

Minerals=salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; iron sulfate, 4.

*See footnote under Table 1.

In the case of the limited-fed lots, each increase in the fat content of the ration resulted in an increase in the rapidity of the gains and in the efficiency of the ration. The difference in energy value was sufficient to account for only a portion of the saving in feed per unit of gain which resulted from an increased amount of fat in the ration.

There were four groups of pigs in the 1940 experiment. Two were fed the medium-fat ration used the preceding year. It contained 5.6 per cent of fat. Two were fed the same feeds with the corn oil reduced from 3.1 to 1.6 per cent of the ration and the grain increased accordingly. This mixture contained 4.2 per cent of fat, which is approximately the same amount as a corn and tankage ration contains. As in the previous trial, one group on each ration was self-fed for rapid gains and one was given a limited allowance of feed to force them to gain more slowly. Table 2 summarizes the results secured.

Regardless of whether full or limited feeding was practiced, the pigs fed the ration containing the larger amount of fat gained more rapidly and required less feed per unit of gain than those fed the ration which was lower in fat. The difference in the energy value of the two rations would account for only a part of the difference in the amounts of feed required per unit of gain.

In 1941 a third experiment to study the effect of feeding rations containing different amounts of fat was conducted. The grain mixture was the same as was used in the previous experiments. The protein concentrate was a mixture of fish meal, 2; soybean oil meal, 1; cottonseed meal, 1. Four per cent of alfalfa and one per cent of minerals were included in the rations. Before and after the pigs averaged 125 pounds in weight the amounts of the protein concentrate fed were those that would result in rations containing approximately 16.6 and 14.5 per cent of total protein, respectively. The fat content was changed by adding cocoanut oil. Cocoanut oil is firmer than corn oil. Their average refractive indexes approximate 1.4485 and 1.4673, respectively.

Table 3 gives the results of the experiment. Each increase in the amount of fat increased the rapidity of the gains and the amount of gain produced, both per unit of feed and per unit of energy value received.

The pigs receiving the rations higher in fat took less feed daily a head than those receiving the rations lower in fat. This was also true of the self-fed pigs in the other experiments. Apparently the palatability of the feed was reduced by the addition of fat, or else the appetite was satisfied with smaller quantities of the rations that were higher in fat.

The effect of fat in stimulating the rapidity of the gains and in reducing the feed required per unit of gain helps to explain some rather puzzling experimental results.

In experiments reported on page 22 of Ohio Experiment Station Bulletin 452, pigs in dry lot fed raw soybeans as a supplement to corn, minerals, and alfalfa required 18.4 per cent more feed per 100 pounds of gain than similar pigs fed tankage. Others fed cooked soybeans required 12 per cent less feed per 100 pounds of gain than those fed tankage. Assuming that cooking improved the proteins, results approaching or equalling those from tankage would not have been unexpected, but to find that the cooked soybeans consistently gave results superior to those obtained from tankage was rather surprising. The findings, however, are in accord with those reported here. With the fat in corn, tankage, soy-

TABLE 3.—Effect of fat on the rate and efficiency of gains of pigs

	1	2	3
Proportions fed until pigs averaged approximately 125 pounds in weight	Grain 81.0 Protein concentrate 14.0 Ground alfalfa 4.0 Minerals 1.0	Grain 77.1 Protein concentrate 14.8 Ground alfalfa 4.0 Minerals 1.0 **Cocoanut oil 3.1**	Grain 73.2 Protein concentrate 15.6 Ground alfalfa 4.0 Minerals 1.0 **Cocoanut oil 6.2**
Proportions fed after pigs averaged approximately 125 pounds in weight	Grain 85.8 Protein concentrate 8.8 Ground alfalfa 4.0 Minerals 1.4	Grain 81.9 Protein concentrate 9.6 Ground alfalfa 4.0 Minerals 1.4 **Cocoanut oil 3.1**	Grain 78.0 Protein concentrate 10.4 Ground alfalfa 4.0 Minerals 1.4 **Cocoanut oil 6.2**
Fat in ration, pct.	**2.6**	**5.6**	**8.7**
Number of pigs	14	14	14
Initial weight per pig, lb.	60.0	59.8	59.8
Final weight per pig, lb.	198.5	208.0	202.8
Average daily gain, lb.	**1.31**	**1.41**	**1.46**
Days to gain 160 pounds	123	114	110
Daily feed per pig, lb.:			
Grain	4.43	4.14	3.80
Protein concentrate	.58	.61	.64
Ground alfalfa	.21	.21	.20
Minerals	.06	.06	.06
Cocoanut oil	....	.16	.31
Total	5.28	5.18	5.01
Feed per 100 lb. gain, lb.:			
Grain	339.22	293.42	260.15
Protein concentrate	44.46	43.31	34.69
Ground alfalfa	16.20	14.69	13.73
Minerals	4.99	4.53	4.17
Cocoanut oil	....	11.39	21.28
Total	**404.87**	**367.34**	**334.02**
Feed per 100 lb. gain with fat times 2.25*.	417.96	393.18	380.50
Cost of feed per 100 lb. of gain	$ 7.12	$ 7.23	$ 7.49
Value of added fat per lb.	....	7.00¢	7.60¢

Grain: ground yellow corn, 1; ground wheat, 2.
Protein concentrate: fish meal, 2; extracted soybean oil meal, 1, expeller cottonseed meal, 1.
*See footnote under Table 1.

beans, and ground alfalfa figured as 3.8, 8.8, 17.2, and 1.9 per cent, respectively, the ration containing tankage and the one containing cooked soybeans analyzed 4.1 and 5.9 per cent of fat, respectively.

In nine dry-lot trials, which were conducted at the Ohio Experiment Station, from 1916 to 1920, pigs carried from 57 to 206 pounds in weight and fed corn and tankage or corn, tankage, and minerals gained 1.30 pounds daily a head and required 389 pounds of feed per 100 pounds of gain produced. In 16 other dry-lot trials, which were conducted from 1922 to 1928, pigs carried from 50 to 201 pounds in weight and fed corn and tankage or corn, tankage, and minerals gained 1.02 pounds daily a head and required 410 pounds of feed per 100 pounds of gain produced.

These data support the belief that much of the more recently manufactured tankage has a lower nutritive value than did the tankage manufactured a number of years ago. Since it is known that the internal

organs are relatively rich in vitamins, more liver and "fancy meats" than formerly are now used for human consumption. Materials of the same kind not used for human consumption command a higher price in dog foods than are secured for them in tankage. A smaller percentage of them in tankage would be expected to lower its supplemental value. Perhaps improvement in rendering equipment and methods which enable the removing of a larger amount of fat is also a factor which has a tendency to cause tankage to show a lower feeding value than formerly. The fifteenth edition of Henry and Morrison's *Feeds and Feeding* published in 1915 gives the average fat content of 55 to 60 per cent protein tankage as 13.0 per cent. In the twentieth edition, published in 1936, the average amount of fat in 60 per cent protein tankage is given as 8.8 and that in 55 per cent protein tankage, as 10.1 per cent.

Since there is danger of producing soft pork if the ration contains more than 4.5 per cent of such fats, adding much softening fat to the ration is not advisable even when it is economical. Nevertheless, it is sometimes possible to take advantage of the favorable effect of a liberal amount of fat in the ration. The tankage from small packing plants is often relatively high in fat. If available, a high-fat tankage would raise the fat content of the ration without resulting in soft pork. This would probably also be true of other feeds containing a solid rather than a liquid fat.

SUMMARY

Rations containing 2.6, 5.6, and 8.7 per cent of fat were compared, both for self- and for limited-feeding in the first and for self-feeding in the third experiment. Rations containing 4.2 and 5.7 per cent of fat were compared both for self- and for limited-feeding in the second experiment. The pigs were confined indoors. The fat content was changed in the first two by the addition of corn oil and in the third by the addition of cocoanut oil.

Full-fed pigs that received rations relatively high in fat took less feed daily a head than those receiving rations lower in fat. Apparently the fat reduced either the palatability of the feed or the amount needed to satisfy the appetite.

Up to the highest level tried, each increase in the percentage of fat in the ration, without exception, increased the rapidity of the gains and the amount of gain per unit of feed consumed. With one exception, the increase in the energy value of the higher fat ration was insufficient to account for all of the saving in feed per unit of gain.

Usually the price of fats is such that it is not economical to include them in the ration, except as they are present in the feeds of which the ration is composed.

Since not much more of a softening fat than is present in corn can be fed without danger of producing soft pork, advantage cannot often be taken of the beneficial effect of a rather high level of fat in the ration without lowering the quality of the pork. Sometimes it may be possible to profit from using a feed that is comparatively high in a firm fat. For example, the fat in tankage is of animal origin and usually firm; hence, a tankage that is relatively high in fat is not likely to have a softening effect.

GETTING THE BEST RETURNS FROM THE NEW CROP OF PULLET LAYERS

D. C. KENNARD AND V. D. CHAMBERLIN

The new crop of pullet layers will need many special considerations if they are to do their wartime best. These ready-to-lay pullets represent much valuable time, feed, labor, and painstaking care in addition to their cash investment. Whether or not the pullets will yield the eggs so urgently needed and prove a paying venture will be largely determined by when and how they are moved from range to laying quarters and their management during the first 4 to 6 weeks of egg production. Many a pullet's chances for becoming a profitable layer have been ruined by failure to provide or prepare suitable laying quarters and facilities and by what happened between the time she left the range and finally became settled and adjusted to the laying house.

PREPARING LAYING QUARTERS

The first essential is to provide ample room. Each Leghorn pullet will need 3 to 3.5 square feet floor space (including droppings pits), and each of the heavier breed pullets will need 4 square feet. Pullets in excess of these requirements should be sold. The second essential is to clean and spray the laying quarters and equipment thoroughly, one to 3 weeks before bringing in the pullets, with creosote wood preserver, an anthracine oil spray, or other effective insecticides to kill the lice and mites. Lice and mites must be considered present in laying quarters unless previously cleaned and sprayed by an effective insecticide. Last, but not least, rats harboring in or nearby must be eliminated, the harbors removed, and the laying quarters and surroundings made ratproof. Rats not only eat and waste valuable feed and spread disease, but they often attack or kill pullets.

MOVING THE PULLETS FROM RANGE TO LAYING QUARTERS

Moving the new crop of pullets from range to laying quarters is comparable to the harvesting of grain or the picking of fruit in that there is a certain opportune time when the pullets should be transferred to the laying house, just as there is a very definite time for the harvesting of grain and the picking of fruit. At best, the moving and radical change from range conditions to the laying house is a critical time for pullets, particularly if they have started to lay. Consequently, the best time for moving pullets to their permanent laying quarters is from one to 3 weeks before they are ready to lay to provide a preadjustment period in the laying house before they start to lay. Unfortunately, a few pullets always begin to lay a few weeks before the majority should be taken from the range. This problem can be solved by taking the earliest maturing pullets to the laying house just before they start to lay and continuing this selective procedure until the majority have been transferred. When possible, the earlier and later maturing pullets should be penned separately. If it is not practicable to house the pullets at frequent intervals as they approach egg production, the usual practice is to move all or a majority of the pul-

lets when a considerable number are about ready to lay, or when egg production on the range is between 5 and 10 per cent.

In every flock of pullets on range are four kinds of pullets: (1) The best, up-to-size, earliest maturing pullets with the best indications of health and vigor. (2) The second best in size and rate of maturity with good indications of health and vigor, all of which should be kept for layers. (3) Those distinctly third-grade pullets in point of size, maturity, and more or less questionable indications of health and vigor. Such pullets should be sold as meat or otherwise disposed of. No such pullets should be kept as layers. (4) Culls.

Many liabilities attend moving pullets from range after they start to lay, such as loss of birds and egg production, disease complications, greater liability of pickouts, and the difficulty of the pullets laying on the floor rather than in the nests.

Other liabilities are rough handling, needless fright, overcrowding, and being left too long in catching crates, over-heating, exposure to cold wind, being too long without water or feed, etc. Pullets need to be handled as a highly perishable product. A laying pullet has the additional liability of an egg being broken in the oviduct which generally results in death or permanent injury.

Pullets in 50 per cent egg production can be (but seldom are) moved from range to laying house with no loss of egg production or injury to the pullets, by proper handling and the use of suitable equipment for catching the pullets. This includes catching crates, hinged panels, and catching hooks. All of these are simple and easy to make at home.

While no two poultrymen would employ exactly the same procedure in handling their pullets, one successful Ohio poultryman, profiting by past experiences, does it this way. His primary object is to avoid frightening the pullets and to move them with the least possible disturbance and liability to injury. Consequently, he shuts the pullets in the night before and uses a horse and sled to haul the coops and chickens. The job starts at 4 A. M. or just before daylight when the pullets can be taken directly from the roosts and cooped with the least disturbance and excitement. Only the more mature

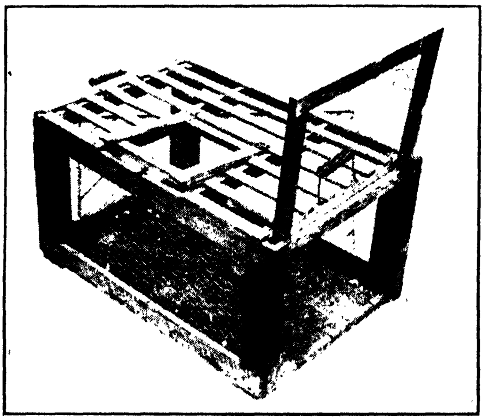

Fig. 1.—A home-made catching crate

pullets are removed from one colony house each morning. This is repeated two times later as the remaining pullets become about ready to lay, so that only one-third of the pullets is removed each time from a given colony house. Obviously, this procedure insures the essential uniformity of pullets in each laying pen.

Pullets carefully moved in this way will be less subject to fright in the laying house, although the same care will need to be continued to avoid fright and keep them tame. A necessary precaution in this connection is for the caretaker never to enter the pen without first rapping on the door to give due warning of his presence. Whatever is done in or about the pen should be done with the greatest care not to frighten the pullets. It is the tame, docile flock of pullets that pays the best dividends.

On the other hand, if pullets become frightened once, they are likely to be frightened by the least provocation afterwards. Roughly handled, frightened pullets often continue to be jittery from one to several weeks or months afterwards. Needless to say, this does not make for profitable egg production.

FIRST FEW WEEKS IN LAYING HOUSE A CRITICAL TIME FOR PULLETS

With the pullets in the laying house come a lot of special duties and responsibilities on the part of the caretaker to help the pullets become adjusted to many things that are strange and different. Often the first shock to pullets removed from a green range to laying quarters is the sudden change from succulent green feed to all-dry feed, which may prove troublesome in various ways. This sudden change to a diet without succulent green feed may cause digestive complications, delayed egg production, feather picking, and cannibalism. To lessen these liabilities, it is well to provide the newly-housed pullets with succulent green feed, such as cabbage, mangels, lawn clippings, kale, green clover, alfalfa, or green leafy clover, alfalfa, or soybean hay during the first few weeks. Not only does this continue to provide the green feed to which the pullets have been accustomed and need, but it gives them something to keep them busy more of the time, which, in itself, tends to prevent feather picking and cannibalism.

The greatest liability of feather picking and cannibalism (pickouts) is during the first few weeks after the pullets are housed. Some of the contributing factors follow:

Overcrowding.—This is such a common cause of feather picking and cannibalism that it should be expected as a penalty for failure to provide ample room for newly-housed pullets.

High indoor temperature.—Heat either from the lack of ventilation or hot weather, is often a contributing cause of the vices of feather picking and cannibalism among early hatched pullets housed during July, August, and September. In many instances, early hatched pullets are objectionable because they start to lay and must be housed during warm weather when there is a greater liability of chicken vices and other complications which are attended with serious losses each year. Good heat insulation of the laying quarters may reduce the liability of the vices.

A high intensity of daylight.—In the laying house this was found to be a contributing cause of chicken vices. Consequently, the amount of window space in the Station's laying houses has been reduced to what is needed for light and ventilation, which is one square foot of window space to each 25 to 40 square feet (depending upon the direction of exposure and width of the laying house) of floor space, a

reduction to about one-third of the customary window space generally provided in laying houses. Moreover, effective insulation of the laying quarters, a warm weather preventative of chicken vices, necessitates elimination of needless window space. Frequently one of the best procedures for the prevention of the vices among newly-housed pullets is to darken the laying pens by covering part of the window space with dark colored paper, cardboard, cloth, or burlap, and leave only the amount of open window space at the top to provide the necessary ventilation.

Tipping the upper beaks.—Often the most effective positive means of prevention and control of feather picking and cannibalism is to tip the upper beaks. Beak tipping to be effective without injury to the birds and without loss of egg production necessitates the use of the cut-tear procedure discovered at the Ohio Agricultural Experiment Station, by which a large portion of the upper beak can be removed without bleeding or injury that affects egg production. To cite a typical example, an epidemic of pickouts occurred in a pen of the Station's Rhode Island Red pullets on January 1, 1943. The upper beaks of all the pullets were promptly tipped and the pickouts ended. The egg production of these pullets averaged 42 per cent during the 10 days previous to debeaking and 46 per cent during the 10 days afterwards.

Rats.—When rats are present in the laying quarters, they not only eat and waste feed and spread disease but may also cause an epidemic of pickouts by nipping the vents of roosting pullets at night. The pullets with bloody wounds from the previous night attack of rats then become daytime pickouts from attacks of their sisters. Under no circumstances, should rats be permitted to harbor in or about the laying quarters.

Feeding and management.—Feeding and management also play an important role in the prevention and control of chicken vices. The value of feeding succulent green feed or green leafy legume hay for the prevention or control of chicken vices among newly-housed pullets has been previously emphasized. Giving the pullets free access to whole oats tends to prevent or control feather picking and cannibalism; whereas, in the Station's experiments with the free-choice feeding of whole corn to pullets, the tendency was increased. In tests with pullets on wire floors, the incidence of feather picking and cannibalism was greatly increased. Peat moss floor litter and filthy litter tended to increase the liability in comparison to straw or shavings, which were removed and renewed with sufficient frequence to keep them in wholesome condition.

OTHER CONSIDERATIONS WITH RESPECT TO NEWLY-HOUSED PULLETS

Never mix pullets and hens.—Pullets are seriously handicapped by being cowed into subordination by hens. What is more, hens are almost invariably carriers of diseases and parasites to which pullets are highly susceptible, unless already handicapped by previous contact with hens.

Teach the pullets to roost.—Every pullet should be made to roost the first night and each night to follow until they all go to roost of their own accord; with Leghorns, this is generally 3 to 7 days after housing, but with the heavier breeds, a longer period may be required. Some of the pullets will take to roosting in or on the nests or other undesirable places. This must be prevented the first night and each following night until they no longer persist in doing so.

Fig. 2.—How to debeak chickens
A—The first cut at one side of the beak
B—After a slight prying and pulling against the flat side of a knife blade, the tip of the beak is removed.

Fig. 3.—A—Cockerel after removal of tip of upper beak
B—Tips of upper beaks after removal

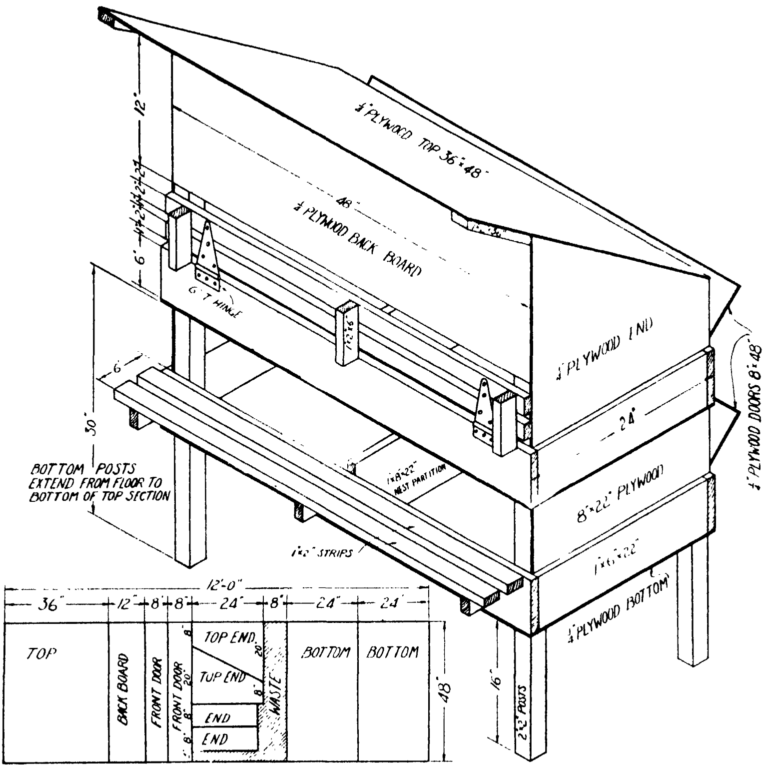

Fig. 4.—Box nests

Closing the nests at night is often necessary.

Start pullets to lay in nests.—An ample number of suitable, properly located nests is essential to success with pullet layers. Inadequate, ill-adapted nesting equipment is the primary cause of floor eggs. Floor eggs are often soiled and more exposed to breakage. Moreover, floor eggs may give rise to the vices of egg eating and pickouts. Broken or weak shelled eggs on the floor tempt the pullets to start the egg eating habit, after which no egg on the floor or in the nests is safe from attack. Pullets laying on the floor in an exposed position are subject to attack by other birds. This is a common cause for epidemic outbreaks of pickouts.

Each single nest will serve four or five layers. A two-compartment box type of nest 20 inches wide and 4 feet long, in which one compartment will accommodate several layers at one time, will serve 50 pullets. The nests need to be darkened and located where most attractive (in a darkened corner or secluded part of the room) to the pullets. The nests should provide plenty of ventilation, especially during warm weather.

Feeders.—A suitable feeder is one that is wasteproof and does not have too much feed capacity, not more than 4 inches deep and 6 or 8 inches wide inside. Waste of feed can be

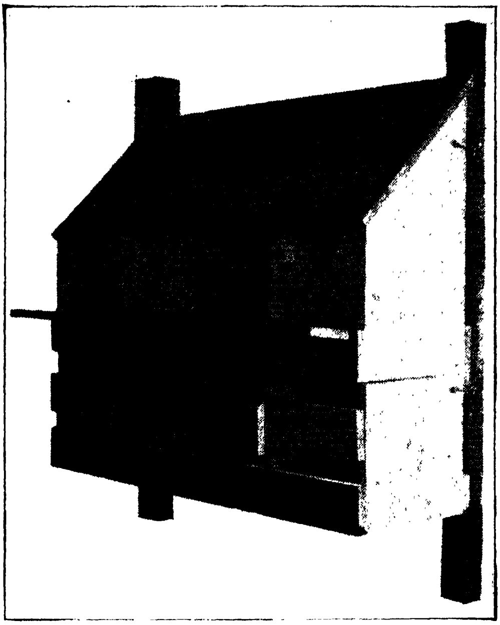

Fig. 5.—Single wall nests

prevented by nailing a plaster lath flatwise on the top edges of the feeder, so that the lath extends one inch inside the feeder, by never filling the feeder more than half full, and by feeding only the amount that will be about consumed between each feeding period. A feeder 6 to 8 feet long (12 to 16 feet of feeding space) should be provided for each 50 pullets.

Artificial light.—For best results in egg production, artificial morning light (to provide 12 to 14 hours of light including daylight daily) is necessary from the first of October to the first of April. A 25-watt electric bulb which, by means of an alarm clock and a simple home-made time-switch device, can be made to turn on the light whenever desired, will serve each pen of 50 to 100 pullets.

SUMMARY

In this discussion, reference has been made to the prevention and control of lice and mites, feather picking and cannibalism, tipping beaks, prevention and control of rats, catching and moving equipment for the transfer of pullets to laying houses, nesting and feeding equipment, and the time-switch device for lighting the laying house without giving details of these procedures. Published detailed information on these subjects can be secured by writing to the Ohio Agricultural Experiment Station at Wooster.

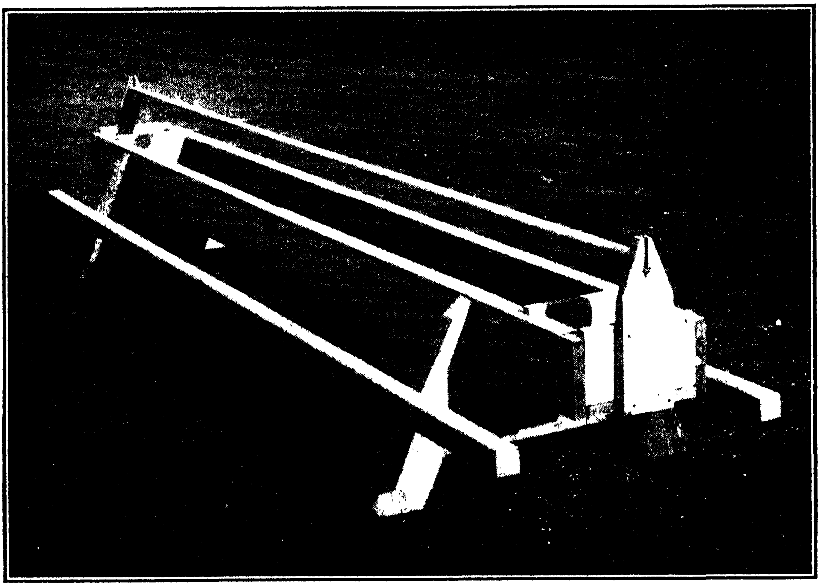

Fig. 6.—New design mash feeder for layers

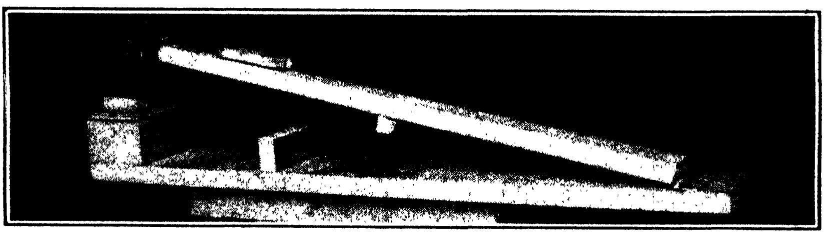

Fig. 7.—Time-switch device for morning lights

EFFECTS OF EVERY-OTHER-DAY MILK DELIVERY IN COLUMBUS, CANTON, AND DAYTON

C. G. McBRIDE

Every-other-day milk delivery was established in several cities in Ohio in the early part of 1942. Three cities with a range of employment conditions were selected for the study. The objective was to measure consumer acceptance in terms of effect upon method and quantity of purchase and the reduction in truck mileage covered in milk delivery.

Ten to twelve sample areas were selected in each city to give a range in levels and conditions of living. Census and city directory data were used in selecting the areas. An area in most instances comprised the homes on both sides of the streets surrounding a city block. Of the 60 to 75 homes in an area, interviews were obtained at approximately 50. Stores in the vicinity of the areas were visited. Interviews were also held with the leading milk distributors in the three cities.

Families fell into five groups with respect to methods of milk purchase. They were those purchasing from (1) home delivery only, (2) a part from home delivery and some in addition from another source, (3) from stores only, (4) from farms in the country only, and (5) families that purchased no fresh milk from any source. In table 1 the families interviewed are classified on this basis.

On the basis of living levels and conditions the areas were designated as high, medium, low, and defense housing. Two areas near the city limits of Canton and two on the edge of Dayton were comprised of homes or trailer camps recently established for occupation by workers in war industries. In table 2 purchases are given on a per capita basis. One of the striking results of this analysis is the high level of home purchase of milk in these special housing areas. Another significant thing shown in this table is the higher average purchase of the groups buying from multiple sources and from the country.

The object in interviewing housewives was to determine to what extent every-other-day delivery of milk had influenced both the quantity and the method of purchase. Each housewife was asked to what extent she had changed her milk buying procedure as a result of every-other-day delivery. The replies are tabulated in table 3. They reveal no significant disturbance of the normal pattern of

TABLE 1.—Sources of milk purchased by families in Columbus, Canton, and Dayton

City	Families interviewed	Home delivery only	Home delivery and other	Store only	Country only	No fresh milk
	No.	*No. of families*	*No. of families*	*No. of families*	*No. of families*	*No. of families*
Columbus	505	269	77	125	14	20
Canton	583	423	39	58	51	12
Dayton	540	386	53	88	8	5
Total	1628	1078	169	271	73	37

TABLE 2.—Per capita milk purchases by income areas and method of purchase in three Ohio cities, September and October, 1942

Area	Total families	Method of purchase				Buy no fresk milk	Daily per capita purchase			
		Home delivery	Multiple source	Store only	Country only		Home delivery	Multiple source	Store only	Country only
	No.	*No. of families*	*No. of families*	*No. of families*	*No. of families*	*No. of families*	*Qts.*	*Qts.*	*Qts.*	*Qts.*
					Columbus					
High.......	144	119	16	5	1	3	0.476	0.542	0.333	0.750
Medium...	209	95	48	53	9	4	.410	.461	.380	.646
Low.......	152	55	13	67	4	13	.243	.256	.274	.635
Total......	505	269	77	125	14	20	.....	....	....	....
Average...	....	....	....	....	....	....	.405	.443	.321	.650
					Canton					
High.......	146	124	4	6	12	....	.427	.357	.260	.426
Medium...	151	109	13	9	16	4	.356	.524	.290	.413
Low.......	151	86	11	36	11	7	.304	.382	.242	.500
Defense ...	135	104	11	7	12	1	.422	.391	.367	.339
Total	583	423	39	58	51	12	......	....	....	....
Average...	....	....	....	....	....	....	.382	.429	.282	.418
					Dayton					
High.......	151	109	27	9	4	2	.459	.473	.445	.438
Medium...	145	117	7	18	3	....	.339	.348	.233	.579
Low.......	148	78	13	55	....	2	.331	.462	.296	.000
Defense ...	96	82	6	6	1	1	.453	.421	.424	.380
Total......	540	386	53	88	8	5	....	....	.....	....
Average...	....	......	....	....	......	....	.396	.448	.307	.484

distribution. Of the 1628 families interviewed, 118 reported some changes but in most instances they consisted of the purchase of a few quarts of milk from the store to supplement home delivery. In these 118 cases there were only 10 that shifted their entire purchase from home delivery to stores and one that shifted to purchase in the country. When asked to list the inconveniences due to every-other-day delivery, most replies referred to lack of sufficient refrigerator space or something related to it such as difficulty of keeping milk fresh. Second in number was the difficulty of adjusting to the changed delivery schedules.

Some significant data were collected on the pattern of distribution by the distributors serving the areas studied. Each of the three markets showed a considerable concentration in a relatively small number of concerns and widely scattered stops by the remainder. This is shown in part by the grouping of distributors in table 4. In the 33 areas in which 57 dealers made home deliveries there were 76 instances of a distributor making but one delivery in a group of approximately 50 homes. It is evident that some exchange of customers by these distributors would result in a considerable saving of delivery mileage.

TABLE 3.—Changes in consumers' weekly purchase due to every-other-day delivery

City	No. changed	Total purchases		Change due to every-other-day delivery				Changed all purchases	
		Home delivery	Store	Home delivery		Store purchase			
				More	Less	More	Less		
		Qts.	*Qts.*	*Qts.*	*Qts.*	*Qts.*	*Qts.*	*No. of families*	*Qts.*
Columbus	45	429	170	24	184	144	....	7	87
Canton	35	415	39	51	73	27	23	1	10
Dayton	38	275	78	20	107	67	4	3	35
Total	118	1119	287	95	364	238	27	11	132

It was difficult to obtain an accurate measure of the effect of every-other-day delivery alone upon mileage covered in milk distribution. Some of the savings on trucks and tires came from elimination of all call-backs and special deliveries and was not separated from that due to every-other-day delivery. A more confusing factor was the growth of retail sales that coincided with change in delivery.

In Columbus there was no great change in volume of sales. Here the nine distributors interviewed reported a reduction of 40 per cent in routes driven and 21 per cent in drivers employed. In Canton where sales increases had been somewhat greater, 18 distributors reported 35 per cent reduction in routes and 25 per cent in drivers. In Dayton where the growth of population was very rapid, sales were increasing so rapidly that many large routes were divided and one-half was delivered one day and the other half the next. This resulted in a reduction of but 5.4 per cent in routes and 1.8 per cent in drivers but the reduction in mileage from every-other-day delivery ranged from 30 to 48 per cent. It is obvious that had these distributors continued with every-day delivery it would have been necessary for them to increase both miles driven and men employed.

The conclusions drawn from the study were that milk distributors, by means of every-other-day delivery, made substantial reductions in use of trucks and tires and released some man-power for other work. The change in delivery schedules did not affect greatly the purchasing pattern of the 1628 families interviewed in the study. The housewife accepted it cheerfully as a necessary war measure and did not find its inconvenience sufficient to induce her to change buying plans.

TABLE 4.—Homes served by milk distributors

City	Families interviewed	Distributors interviewed	Total stops	Average by groups			Families served by 2 distributors
				Five highest	Five lowest	All	
	No.	*No.*					
Columbus	505	20	354	63	1	18	4
Canton	583	25	477	66	2	19	15
Dayton	540	12	444	78	3	37	5
Total	1628	57	1275	207	6	74	24

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

Four years after the beginning of World War I the prices of Ohio farm products stood at a level of 202; in the present war, at 193.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	.....	101	101	104	100	105	101
1914	99	.....	100	101	102	102	105	109
1915	102	.....	105	98	103	107	106	112
1916	125	.....	124	118	113	113	121	123
1917	172	.....	149	175	140	119	182	201
1918	192	.....	176	202	175	131	203	243
1919	202	.....	202	213	204	135	218	276
1920	225	.....	201	211	236	159	212	230
1921	142	.....	152	125	164	134	132	134
1922	141	.....	149	132	145	124	127	133
1923	147	.....	152	142	160	122	134	147
1924	143	.....	152	143	165	118	133	150
1925	151	.....	156	156	165	110	159	180
1926	146	.....	155	145	170	105	155	183
1927	139	.....	153	139	173	99	147	171
1928	141	.....	155	149	169	96	154	163
1929	139	.....	154	146	169	94	151	172
1930	126	.....	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	140
1939	113	103	121	93	117	76	95	140
1940	114	117	122	98	116	77	99	146
1941	127	170	131	122	138	80	121	185
1942	144	227	154	157	173	89	157	244
1942								
January	140	192	146	149	153	.....	141	201
February	141	199	147	145	.....	.....	144	183
March	142	208	150	146	.....	89	146	208
April	144	210	151	150	167	.....	153	230
May	144	216	152	152	.....	.....	157	241
June	144	222	152	151	176	.....	157	232
July	144	230	152	154	179	.....	159	237
August	145	233	152	163	.....	.....	164	248
September	145	237	153	163	.....	.....	161	268
October	145	249	154	169	193	.....	165	290
November	146	258	155	169	.....	.....	167	293
December	147	267	156	178	.....	.....	169	297
1943								
January	149	268	158	182	196	.....	174	283
February	149	275	160	178	.....	.....	177	261
March	150	282	161	182	.....	97	181	287
April	151	284	162	185	212	.....	190	296
May	152	.....	163	187	.....	.....	197	318
June	.....	.....	.....	.....	221	.....	193	.....

*SOURCE: Bureau of Business Research, The Ohio State University.

BIMONTHLY BULLETIN

VOL. XXVIII NOVEMBER DECEMBER, 1913 NO. 225

YOUR AUTHORS

Already familiar to Bimonthly Bulletin readers are the authors of this issue: D. C. Kennard, poultry specialist, Alex Laurie of the Division of Floriculture, F. L. Morison and J. I. Falconer of the Department of Rural Economics.

The cover photograph is another in the series by Harry G. Binau, Experiment Station photographer.

IN THIS ISSUE

THIN-SHELLED EGGS, THEIR CAUSES AND REMEDIES

D. C. KENNARD AND V. D. CHAMBERLIN

Thin- or weak-shelled eggs cause trouble for egg producers, egg handling and marketing agencies, hatcheries, and consumers. Great market losses occur from cracked or broken weak-shelled eggs. Thin-shelled eggs break in nests, fouling other eggs and the nesting material. Such eggs break in gathering containers and egg cases, foul other eggs and the containers. Some poor-shelled eggs may reach the consumer. Thin-shelled eggs are unfit for hatching or cold storage. Furthermore, weak-shelled eggs are primarily responsible for hens' eating their eggs.

Principal causes for thin-shelled eggs are deficient diet, warm weather, advanced age of layers, and heredity.

Since egg shells are about 94 per cent calcium carbonate and constitute about 30 per cent of the total solids of normal eggs, the first and principal mineral requirement for egg shell formation is calcium carbonate, which is generally provided by keeping oyster shells or 90 to 95 per cent calcium carbonate limestone grit before layers at all times. In addition, layers must have ample vitamin D to render the calcium available for assimilation into egg shell material. Regardless of how much oyster shell or limestone material the layer consumes, the calcium is useless without an adequate amount of the vitamin D factor to render it available for egg shell formation.

When eggs are broken in nests or hens are seen eating eggs, the poultryman should examine a number of the eggs to see whether they are thin shelled. The thin shell condition comes on gradually and often escapes notice until the trouble stage has been reached. If there is evidence of poor shell texture, the first causes to suspect and correct are dietary deficiencies. When the diet is responsible with layers confined indoors, the cause is probably a deficiency of vitamin D, if the layers have access to oyster shells or 90 to 95 per cent calcium carbonate limestone grit at all times.

The vitamin D factor, as provided by direct sunshine, sunlamps, vitamin D feeding oil, or other vitamin D supplements, is necessary in the diet to enable the layers to assimilate the necessary calcium for egg shell formation and other body functions. The supplemental requirement for layers in general, including breeders, from October 1 to April 1 when confined indoors is 350 to 450 AOAC chick units per pound of total feed intake. The requirement for hatchable eggs is greater than for market egg production. The four principal causes of vitamin D deficiency are:

Failure of layers to consume sufficient mash, which contains the vitamin D supplement, when whole grain is fed unrestricted in addition to the mash

Insufficient vitamin D supplement in the mash

Deterioration of the vitamin D after preparation of the mash

Lack of potency of the vitamin D supplement

A case of lack of potency of the vitamin D supplement occurred at the Ohio Agricultural Experiment

Station in February 1935. The feeding oil in use did not contain its guaranteed content of vitamin D, a not uncommon experience before the more dependable standardization of vitamin D supplements. When a large proportion of the eggs from layers in batteries had weak or thin shells and many were lost from breakage, the amount of vitamin D feeding oil in the mash was doubled, and the condition of the egg shells promptly improved.

Poultrymen troubled with poor shell texture of eggs from layers confined indoors should determine whether the trouble is due to a deficiency of vitamin D in the hens' diet by doubling the amount of vitamin D feeding oil or other vitamin D supplement used. If after 4 weeks there is a noticeable improvement in the condition of the egg shells, the cause of the poor-shelled eggs is obvious. If no improvement in the egg shell texture is observed, it can be assumed that the trouble is due to some other cause. Usually, however, insufficient mash consumption to provide the necessary amount of vitamin D or an insufficient addition of the vitamin D supplement to the mash is the cause.

Deficiency of vitamin D and poor shell texture are generally most acute from January to May. Layers in batteries are more subject to a deficiency of vitamin D than those confined to indoor floor pens; layers with an opportunity to be out of doors during the winter months when weather permits are seldom affected.

Poor egg shell texture beyond immediate means of prevention or control may be caused from failure of the egg shell-forming organs to function properly because of disease complications affecting the oviducts.

An extreme instance of poor shell texture, apparently due to disease complications affecting the oviducts or shell-forming organs, occurred in a group of the Station's Leghorn pullets in batteries in 1932. This group of pullets was part of an experiment in which pullets were purposely raised on disease- and parasite-contaminated range in comparison with other groups of similar pullets raised on clean range or confined to wire sun porches. So many of the eggs from the pullets raised on the contaminated range had thin shells that 14.3 per cent of the eggs laid from December 5 to August 25 passed through the wire bottoms of the batteries. In fact, many of the eggs were soft shelled (shell-less). In contrast, less than 1 per cent of the eggs from the other groups were soft shelled. In addition, the pullets not exposed to contaminated soil laid 40 more eggs per bird (including the 14.3 per cent lost eggs), or 56 more marketable eggs per bird during 38 weeks, and the mortality rate was approximately one-half that of the pullets raised on contaminated soil. Although this was an extreme, perhaps unusual, instance of poor-shelled eggs apparently due to disease complications affecting the shell-forming organs, such cases may occur in varying degrees of intensity in farm and commercial laying flocks without being recognized. It was because the Station's pullets were in batteries that an accurate account of the weak- or soft-shelled eggs could be recorded. There is no way of knowing how many weak- or soft-shelled (shell-less) eggs may be lost in floor pens.

How thin-shelled eggs encourage hens to eat their eggs was demonstrated in some of the Station's early experiments in which some groups of layers confined indoors received a ration with cod-liver oil to provide ample vitamin D, while others received the same ration without the vitamin D oil. After 2 to 3 months,

the eggs from the layers on the vitamin D-deficient ration became thin shelled, and the birds started to eat them. Soon few eggs could be collected from this pen. Just as soon as an egg was laid, especially on the floor, the birds scrambled for it. When an egg from the cod-liver oil pen was put on the floor of the pen of the layers not receiving cod-liver oil and withstood their attack, the egg eaters gave up their attempts at egg eating. Of course, some poor management procedures, such as faulty and inadequate nesting equipment, too much light in nests, overcrowded nests and broken eggs, failure to gather eggs frequently, and floor eggs, are also responsible for egg eating.

Many egg producers have experienced as much difficulty in securing oyster shells or 90 to 95 per cent calcium carbonate limestone grit to produce the shell of the egg as in securing some of the other feedstuffs to produce the contents.

A suitable source of lime or calcium is as essential for egg production as any part of the hen's diet. The calcium for egg shell formation is generally provided by oyster shells or 90 to 95 per cent calcium carbonate limestone grit. When layers do not have free access to oyster shells or high-calcium limestone grit, reduced egg production, thin-shelled eggs, and egg eating generally follow. Consequently, poultrymen should consider it as important to keep the layers provided with oyster shells or 90 to 95 per cent calcium carbonate limestone grit as to keep them provided with a well-balanced mash and whole grain. The same applies to feed merchants.

Poultrymen who are unable to secure oyster shells may be able to secure 90 to 95 per cent calcium carbonate limestone grit. Unfortunately, high-calcium limestone grit suitable for feeding poultry often must be transported long distances, because there is little or no limestone sufficiently high in calcium which is suitable and available for feeding poultry in large sections of the country, including Ohio. Dolomitic limestone, which contains too much magnesium for feeding poultry, is readily available in many sections of the country, including Ohio, but it should not be used for feeding poultry except as a last resort when it is temporarily impossible to secure oyster shells or 90 to 95 per cent calcium carbonate limestone grit.

Oyster shells or 90 to 95 per cent calcium carbonate limestone grit can be included in the mash at the rate of 5 per cent in all-in-one, complete feed mixtures for layers in batteries, or, for layers in general, 1 to 2 per cent can be added to the laying mash for special purposes in addition to the free-choice feeding of oyster shells or high-calcium limestone grit. When either product is added to the mash, the shell flakes or the grit, rather than the pulverized products, should be used.

The purpose of feeding high-calcium limestone grit is for its calcium, and hard grit, such as mica, quartz, or granite, which contains no calcium carbonate, cannot substitute for oyster shells or high-calcium limestone grit. There appears to be little evidence that hard grit is essential for layers kept under practical conditions of feeding and management.

SUMMARY

The two dietary requirements which call for special attention in avoiding thin-shelled eggs are: keeping oyster shells or 90 to 95 per cent calcium carbonate limestone grit available for the layers at all times and providing ample vitamin D in

the diet or sufficient exposure of the layers to direct sunlight to render the calcium available for egg shell formation. Oyster shells or 90 to 95 per cent calcium carbonate grit is as necessary as any part of the hen's ration for egg production. When layers do not have free access to oyster shells or 90 to 95 per cent calcium carbonate grit at all times, or if the diet of hens confined indoors is deficient in vitamin D, thin-shelled eggs, loss of egg production, and hens' eating their eggs are natural consequences.

When eggs from layers confined indoors show signs of poor shell texture, or there is undue loss of eggs from breakage or from hens' eating their eggs, a deficiency of vitamin D is the first cause to be suspected and corrected (assuming, of course, that the layers have free access to oyster shells or 90 to 95 per cent calcium carbonate limestone grit at all times). If additional vitamin D supplement fails to improve the egg shell texture, the cause can be considered due to other factors, over which the poultryman may have no immediate means of prevention or control.

GERMINATION OF BELLADONNA SEED AND EFFECT OF WINTER MULCHES ON PLANT MORTALITY

ALEX LAURIE

SEED GERMINATION

Seed germination of belladonna has not been high, averaging 25 to 40 per cent and sometimes even lower. The tests reported in this article were made to determine the causes and methods of improvement.

The best germination occurred from seed which matured on the plants by being allowed to stay until the seed pods were dry. Under such conditions the seeds are large, well filled, dark colored, and shiny. A certain percentage of seeds harvested from unripe fruits will germinate, however. Cutting tests indicate that dark embryos and endosperms are not objectionable and have little to do with usability.

The need for covering flats depends on the type of medium used. Mediums which dry out readily should be covered to retain moisture about the seeds. For that purpose subirrigation of flats is desirable.

In order to increase germination percentages, several treatments were tried. They were: precooling seeds, based on the assumption that an after-ripening period may be needed; soaking in water; use of sulfuric acid and hydrochloric acid to soften the seed coats; high temperature and moisture. All seed was sown in light loam soil. The results are as given in table 2.

The figures in table 2 are composite for numerous trials. Cooling at 45° F. for a period of several

TABLE 1.—Covering seed flats

Medium	Covered with glass		Uncovered	
	Percentage germination	Days	Percentage germination	Days
Soil	48	23	22	26
Sphagnum	51	13	54	14
Peat	11	30	5	20
Sand	52	25	42	20

TABLE 2.—Seed germination

Treatment	Percentage germination	Days to germinate
Check	25	35
Cooling 2 weeks, 45°	29	39
Cooling 5 weeks, 45°	47	52
Water 7 days, 50°	35	33
Water 7 days, 60°	50	30
Soil 7 days, 60°	55	19
Moist burlap, 90°, 7 days	65	16
Moist soil, 90°, 7 days	89	8
Sulfuric acid, 1 minute	52	10

weeks before sowing had some effect on increasing germination. However, treatment with sulfuric acid, commercial strength (70 per cent), with 1 minute immersion was more effective than cooling and reduced germination time considerably. Of all the treatments tried, high temperature combined with high soil moisture gave the highest germination (in some cases close to 100 per cent) and required the least number of days for emergence above ground.

RESULTS OF MULCHING TESTS OVER WINTER

It has been found that belladonna has a higher alkaloid content during its second year of growth than during the first season. For this reason, some growers attempt to winter the plants. Tests have been conducted to determine the feasibility of wintering the plants. Results of the first year's trials are presented in table 3.

TABLE 3.—Effect of depth of mulches on survival

Depth	Percentage survival
Heavy mulch (12 inches of strawy manure)	76
Medium mulch (6 to 8 inches of strawy manure).	60
Light mulch (3 to 4 inches of strawy manure)....	57
No mulch	9

These tests were conducted on silt loam soil. In heavier soils the survival was less, depending on the amount of clay present and the depth of mulch. Without mulching, practically every plant died in heavy soils. Yet extremely heavy mulches (12 inches) likewise resulted in great loss, largely due to excess moisture present. In heavy soils a 6-inch mulch would be more desirable.

Fertilizer treatments likewise have their effect on survival of plants during the winter. Table 4 illustrates results of various fertilizer treatments. A 6-inch mulch was used on all plots in light loam soil.

TABLE 4.—Effect of mulches on survival of 1-year belladonna plants at different nutrient levels

pH 5.5-6.5		pH 6.5-7.5	
Treatment	Percentage survival	Treatment	Percentage survival
High N, high P, high K*	60	High N, high P, high K	60
Low N, high P, high K	93	Low N, high P, high K	87
High N, low P, low K	48	High N, low P, low K	50
Low N, low P, low K	80	Low N, low P, low K	85
High N, low P, high K	40	High N, low P, high K	33
Low N, low P, high K	85	Low N, low P, high K	76
High N, high P, high K	40	High N, high P, low K	40
Low N, high P, low K	85	Low N, high P, low K	85

*N, nitrogen; P, phosphate; K, potassium.

One year's tests show a consistent trend indicating that high nitrogen content is conducive to greater loss during the winter. Maintenance of low nitrogen levels, particularly toward the last of the season, is a desirable practice. No significant effects were observed from varying the levels of phosphorus and potas-

In general, it would be assumed that carrying belladonna over winter necessitates mulching and low levels of nitrogen. However, since sufficiently high assays are secured from 1-year-old plants, the additional cost of mulching may be questioned.

Mulching tests with several species of digitalis on Fox silt loam showed the results given in table 5. The mulches were 6 inches deep.

TABLE 5.—Effect of mulching on several species of digitalis

	Mulched, percentage survival	Not mulched, percentage survival
Digitalis purpurea	53	9
lutea	100	100
lanata	47	80
ambigua	100	81

UTILIZATION OF OHIO FARM FEED SUPPLIES

F. L. MORISON

The Department of Rural Economics of the Ohio Agricultural Experiment Station was one of several agencies participating in a recent study on "Maximum Wartime Agricultural Production in Ohio." In this study it was necessary to make estimates of the present and probable future amounts of feed consumed by Ohio livestock. For the year beginning October 1, 1942, it was estimated that nearly 6 million tons of feed grains, mill feeds, and other concentrates were consumed on Ohio farms. This tonnage was about 11 per cent greater than was fed in the previous year. A large part of the increase went to hogs and poultry.

TABLE 1.—Estimated percentage of total tonnage of grains and commercial feeds fed to each class of livestock on Ohio farms in the years beginning October 1, 1941-1942

Class of livestock	1941	1942
Horses, mules, and colts	5.6	4.7
Milk cows	16.7	15.3
Feeder cattle	3.6	3.3
Other cattle and calves	6.6	6.2
Feeder lambs	.5	.4
Other sheep and lambs	1.2	1.1
Hogs	45.1	48.9
Hens and pullets	13.2	13.0
Chickens raised	6.5	6.4
Turkeys	.7	.7
Total	100.0	100.0

Table 1 shows what share of the total grain supply went to each class of livestock during the last two crop years. The increased percentage going to hogs in the year beginning October 1, 1942, and how this reduced the share going to other classes, particularly milk cows, should be noted.

TABLE 2.—Estimated percentage of total hay supply fed to each class of livestock on Ohio farms in the years beginning October 1, 1941-1942

Class of livestock	1941	1942
Horses, mules, and colts	18.6	17.3
Milk cows	49.0	49.7
Feeder cattle	2.0	2.0
Other cattle and calves	17.5	18.2
Feeder lambs	1.1	1.0
Other sheep and lambs	11.8	11.8
Total	100.0	100.0

The relative amounts of the hay supply going to various classes of livestock are shown in table 2. Approximately 3½ million tons of hay are fed annually. Of this total, horses receive about one-sixth, milk cows about one-half, all other cattle about one-fifth, and sheep about one-eighth.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

Four years after the beginning of World War I, the price level had risen 96 per cent; it is now 4 years since the beginning of the present war, and the general price level has advanced by 33 per cent.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	...	101	101	104	100	105	101
1914	99	...	100	101	102	102	105	109
1915	102	...	105	98	103	107	106	112
1916	125	...	124	118	113	113	121	123
1917	172	...	149	175	140	119	182	201
1918	192	...	176	202	175	131	203	243
1919	202	...	202	213	204	135	218	270
1920	225	...	201	211	236	159	212	230
1921	142	...	152	125	164	134	132	134
1922	141	...	149	132	145	124	127	133
1923	147	...	152	142	160	122	134	147
1924	143	...	152	143	165	118	133	150
1925	151	...	156	156	165	110	159	180
1926	146	...	155	145	170	105	155	183
1927	139	...	153	139	173	99	147	171
1928	141	...	155	149	169	96	154	163
1929	139	...	154	146	169	94	151	172
1930	126	...	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	140
1939	113	103	121	93	117	76	95	140
1940	114	117	122	98	116	77	99	146
1941	127	170	131	122	138	80	121	185
1942	144	227	154	157	173	89	157	244
1942								
January	140	192	146	149	153	...	141	201
February	141	199	147	145	...	...	144	183
March	142	208	150	146	...	89	146	208
April	144	210	151	150	167	...	153	230
May	144	216	152	152	...	...	157	241
June	144	222	152	151	176	...	157	232
July	144	230	152	154	179	...	159	237
August	145	233	152	163	...	...	164	248
September	145	237	153	163	...	...	161	268
October	145	249	154	169	193	...	165	290
November	146	258	155	169	...	...	167	293
December	147	267	156	178	...	...	169	297
1943								
January	149	268	158	182	196	...	174	283
February	149	275	160	178	...	...	177	261
March	150	282	161	182	...	97	181	287
April	151	284	162	185	212	...	190	296
May	152	289	163	187	...	...	197	318
June	151	293	164	190	221	...	193	318
July	150	291	165	188	229	...	192	320
August	150	...	165	193	...	...	198	333

*SOURCE: Bureau of Business Research, The Ohio State University.

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MEET YOUR AUTHORS!

Monroe

Krauss

Perkins

Hayden

C. F. Monroe, Associate, and W. E. Krauss, Chief, of the Department of Dairy Industry, discuss the effects of levels of fat in the grain mixture on milk and butterfat production. These men join with A. E. Perkins, C. C. Hayden, and R. G. Washburn (Captain Washburn is serving in the Army and is not pictured here.) in the authorship of an article on ensiling carrots. Mr. Perkins also presents another article in his long series on various phases of silage.

Moore

H. R. Moore has been associated with the Experiment Station since 1925. His article on Ohio land values is based upon a study now under way at the Experiment Station, in cooperation with the United States Department of Agriculture.

Judkins

W. P. Judkins, Assistant in the Horticulture Department at the Ohio Experiment Station, tells about the peach situation (for the backyard grower, as well as for the commercial grower). He concerns himself with price and production trends, in addition to purely horticultural advice. Mr. Judkins' second article lists and evaluates peach varieties under several categories.

Wander

Not all the chemicals used in the processes for turning out vital war materials are rendered unfit for further uses. I. W. Wander, of the Department of Horticulture, writes in this issue of one of these war by-products—namely, alkylation phosphate. He compares the effectiveness of this product with 20 per cent superphosphate as a fertilizer for various plants, such as corn, tomatoes, soybeans, ageratum, etc.

Other authors, already familiar to the readers of the Bimonthly Bulletin, who have contributed material for this issue are: J. I. Falconer, rural economist; J. D. Wilson, plant disease specialist; D. C. Kennard and V. D. Chamberlin, poultry specialist; and Alex Laurie, flower specialist. Mr. William K. Steuk, of the Horticulture Department, is a new contributor but is not pictured here.

IN THIS ISSUE

PLACING A VALUE ON SILAGE

A. E. PERKINS

Your dictionary doubtless defines silage about as follows: "A product resulting when green forage, usually chopped, is closely packed into stacks, pits or tight enclosures known as silos." Crops so treated are said to be ensiled. Ensiled crops undergo physiological changes and a greater or less degree of bacterial fermentation which give to the product characteristics seemingly different in many ways from those of the original crop. The use of silos as a means of crop storage is expanding and new crops are fast being added to the list of those stored in this manner. Information regarding the composition and feeding value of the silage made from different crops and under different conditions is thus in active demand.

CHANGES BETWEEN CROP AND SILAGE

The most common and noticeable changes are (a) a change of color from the natural green of the plant to an olive green or brown color, which often darkens when the silage is exposed to air; (b) the disappearance of any sweet taste of the plant juice and the development in its place of a more or less sour taste; (c) the flattening and change in shape of individual pieces of the crop and their blending into a denser and more compact mass; and (d) the development of a more or less pronounced odor which is usually pleasing but sometimes disagreeable and persistent. In either case, it is distinctly different from that of the plant itself.

If described chemically the principal known changes are: (a) disappearance of fermentable sugars; (b) the development of organic acids; (c) a change of some of the plant proteins into simpler and more soluble nitrogen compounds, and (d) the formation of a considerable proportion of volatile products which are vaporized or lost if the silage is dried at temperatures near the boiling point of water. In spite of this formidable list of changes most of the plant material remains comparatively unchanged, and the potential feeding value of the silage, as determined by the usual feed analysis, barring any considerable loss of juice and visible spoilage, is nearly the same as that of the ensiled crop. The word "potential" is used here to limit the term "feeding value," because, although silage is generally highly palatable and readily consumed, serving as an appetizer and conditioner in the ration, sometimes objectionable odors or tastes develop (especially in grass silage which is too wet) so that the silage is eaten only sparingly or not at all. Such a condition would not affect the value as shown by analysis, although the actual feeding value of such silage would be practically zero. The avoidance of such results through a proper control of ensiling conditions is probably the leading aim and purpose of most of our present research concerning silage.

WHY THE LOW PRICE OF SILAGE?

The most striking, and, at first thought, disappointing thing about either the calculated feeding value or price of silage per unit of weight is that it seems so very low in comparison with other feeds. This condition is of course due to the fact that silage is preserved in the fresh or wet condition and contains on the average only about 30 per cent dry matter; whereas feeds, cured and stored in dry form, usually contain about 90 per cent dry matter. The remaining 10 per cent in case of hay or grain or the remaining 70 per cent in case of silage is water of no more value than water supplied from other sources, except as it may improve the palatability and ease of mastication of the feed, reduce wastage, and supply needed water not readily available from other sources.

Since the feeding value of any feed is closely dependent on its dry-matter content, a ton or other unit weight of silage is only about one-third as valuable as the same weight of a similar feed preserved in dry form. The compensation for this disappointment, however, rests in the fact that a given weight of crop will produce about three times as much silage by weight as of hay or dry fodder and grain. Moreover, the 3 tons of silage require only about as much storage space as one-third of a ton of mow-stored hay since the dry-matter density of silage is similar to that of baled hay rather than loose hay.

Silage, because of its wet and heavy nature and its susceptibility to spoilage, can not be readily handled commercially; hence it has no established market price. When transfer of ownership is made or an accounting is desired, the price or value of the silage can best be determined by calculation based on its feeding value and the feeding value and either the farm price or market price of other feeds such as hay or grain. This lends added interest and importance to the comparative feeding value of silage and to the estimation of its weight.

COMPUTING THE VALUE OF CORN SILAGE

Let us first consider the value of the longer known and more familiar corn silage. A 5-year comparison between well-eared field corn and a larger, later maturing corn for silage was made at the Ohio Agricultural Experiment Station. The earlier well-eared corn yielded 10.3 tons per acre and contained 40.6 per cent, or 812 pounds per ton, of kiln-dried grain. The larger, later corn, which was not as well eared, yielded nearly 12 tons of green weight per acre containing 25.3 per cent, or 506 pounds per ton, of dried grain. A figure of 700 pounds or 12.5 bushels as the grain content of a ton of well-eared corn silage would thus seem conservative. In addition, there occurs in the silage about 1,300 pounds of moist roughage which is probably as valuable as one-third of its weight, or 433 pounds of one of the common or cheaper grades of hay. The sum of the prices of ⅕ ton of common grade hay and of 700 pounds of shelled corn at farm price would then seem a fair, though conservative, price for a ton of good corn silage.

Based on chemical analyses converted to the dry basis, good corn silage compares closely in composition with the best grades of mixed grass and legume hay. This indicates that good corn silage has a value of about one-third that of good hay at the time and place of the exchange.

Again, corn silage is closely similar in analysis to dried sugar-beet pulp soaked with three times its own weight of water. One of these feeds can be substituted for the other in feeding operations, with scarcely noticeable effect on the production. One-fourth the price of dried beet pulp would, therefore, seem a fair price for good corn silage. Any of these methods, depending on circumstances, may, therefore, be considered as suitable for determining the price of corn silage. The price of beet pulp however is more subject to manufacturing, commercial, and shipping charges than the others and may indicate relatively high values. By averaging the results of two or even all of these values, one may perhaps obtain a more dependable guide than by using any one method alone.

OTHER SILAGES

Clover, alfalfa, or soybean silages are likely to be about one-half higher in digestible protein than corn silage of the same dry-matter content but somewhat lower in total digestible nutrients. They have been generally reported to be somewhat less palatable than corn silage. The comparisons have commonly been made, however, while using alfalfa hay as the dry roughage. It is quite possible that the comparison would be more favorable to the legume silage if hay from one of the grasses or corn stover was used as the supplementary roughage, as is often done in farm feeding.

Some complaints have come to our attention that production has fallen off when grass silage was substituted for corn silage; on the other hand, others are highly pleased with the results of feeding grass silage. Some of the complaints may be ascribed to the poor quality or condition of the crop as ensiled. Feeding experiments at the Ohio Agricultural Experiment Station have tended to show a slight superiority in production value, as well as in palatability, for the corn silage. The corn silage used in these comparisons was of similar quality to that mentioned previously as containing about 800 pounds of dry grain per ton. The hay crop silages consisted wholly of roughage; that is, they contained no grain whatsoever. This probably accounts for the difference in results and should be fully considered in planning the feeding. A larger allowance of grain which may, however, be of lower protein content should be supplied with the grass silage if heavy production is to be satisfactorily maintained. This is especially true if the hay crop was not of the best quality as ensiled. When grain is added to the hay crop as ensiled to raise the dry-matter content or to serve as a preservative it will go a long way toward equalizing the value of the two kinds of silage.

Corn silage is a fair source and legume or early grass silages of good quality are excellent sources of carotene. The carotene is the substance responsible for the production of vitamin A and of the much desired yellow color in milk and butter. Dry roughages of average quality are generally low in carotene. Usually it is desirable to feed silage in connection with some form of dry roughage as well as grain, because a somewhat greater feed consumption and production are probably obtained in this way; however, either corn silage or grass silage may be fed as the sole roughage if this becomes necessary. Each of these silages has been fed in this way to liberally producing cows at the Ohio Agricultural Experiment Station for periods of several months without serious adverse effect on either cows or production. Large

Holstein cows ate as much as 80 pounds of silage per day under these conditions. Although the liberal use of silage seems to prevent the constipated condition often found in cows which are limited to dry roughage and grain, the use of silage as the only roughage did not cause an undesirable condition in the opposite direction.

THE WEIGHT OF SILAGE

Since it is impractical under most conditions to weigh silage in place or in large quantity, the problem of calculating the weight of the entire content of the silo or the weight of silage remaining after part has been fed frequently becomes important. Several groups of workers have obtained data regarding the weight of settled silage at different depths in the silo. Eckles, Reed, and Fitch (1) of the Missouri and Kansas Experiment Stations published data in 1919 which has been widely used for calculating the weights of silage. Shepherd and Woodward (2) of the United States Department of Agriculture have more recently (1941) reported a careful study made under somewhat different conditions. While the results of these studies vary in detail, they are in rather close agreement in essentials and jointly they seem to provide a reliable basis for estimating silage weights over the range of conditions commonly found.

Both of these studies start with a reference point; namely, the surface of the fully settled silage at the time of opening. The use of this height rather than that of the silo wall is of first importance. Eckles et al. (1) start at the point where feeding begins, omitting the top spoilage; whereas Shepherd and Woodward (2) include the top spoilage along with the rest in the weight estimations. This accounts for part of the difference in estimated weights near the top of the silos but is relatively unimportant. Although their data are not complete in this respect, the earlier workers (1) seem to have used corn of an average dry-matter content of about 35 per cent. This means that their corn averaged slightly past the degree of maturity at which corn is commonly ensiled. The corn used by the others (2) was perhaps slightly lower in dry matter than the average, which is probably about 30-32 per cent. When these figures for the dry-matter content of the respective silages are applied to the average gross weights per cubic foot as shown in table 1 the weight of dry matter per cubic foot of silage is obtained. These values for the respective groups of silages are shown in table 2. Aside from the first few feet at the surface, the weight of dry matter per cubic foot at the different levels shows a remarkably close agreement and indicates that the seeming differences in weights as shown in table 1 are due primarily to the dry-matter level or maturity of the corn ensiled. It also indicates that an average of these weights at the different depths should give a reasonably accurate estimate of the weight of silage of about 31 per cent dry matter. This is believed to be nearer the dry-matter level of silage as put up in Ohio than either 27.6 per cent or 35 per cent, the values applying to the data of Shepherd (2) and Eckles (1), respectively. These average values are shown in two ways in table 3. Column A shows the weight at the respective levels as indicated. If the weight of only a portion of the silage is being considered the weights at the

1. Eckles, C. H., O. E. Reed, and J. B. Fitch. 1919. Kans. Agr. Exp. Sta. Bull. 222 and Mo. Agr. Exp. Sta. 1919. Bull. 164.

2. Shepherd, J. B., and T. E. Woodward. 1941. U. S. Dept. of Agr. Cir. 603.

respective 5-foot levels must be averaged to obtain the proper value of "W" for use in the formula given below. If the entire contents of the silo are being estimated, the figures in column B, giving the average weight of all silage above and including each level, may be used directly. The results of such studies have commonly been given in the form of extensive tables but an attempt is here made to present a summary of the essential data for a sufficiently accurate estimate of the silage weight in more concise form.

TABLE 1.—Weights of silage per cubic foot

Distance below surface of settled silage, including top spoilage	Average weight of silage per cubic foot, at stated level	
	Dry matter—35 per cent*	Dry matter—27.6 per cent†
Feet	*Pounds*	*Pounds*
1- 2†	....	23
3- 5†	....	36
1- 5*	33	....
6-10	37	45
11-15	39	49
16-20	41	52
21-25	42	53
26-30	43	54
31-35	....	55

*Data of Eckles.
†Data of Shepherd.

TABLE 2.—Weight of dry matter per cubic foot of silage

Distance below surface	Dry matter—35 per cent*	Dry matter—27.6 per cent†
Feet	*Pounds*	*Pounds*
1- 5	11.55	10.22
6-10	12.95	12.36
11-15	13.65	13.36
16-20	14.35	14.30
21-25	14.70	14.71
26-30	15.05	14.97

*Data of Eckles.
†Data of Shepherd.

The procedure for calculating the weight of silage in a given silo or portion thereof from the values given in table 3 or table 1 may be briefly stated in the following formula:

$$\text{Weight silage (in tons)} = \frac{0.7854 \times D \times D \times H \times W}{2000}$$

Where—0.7854 is the factor indicating the relationship between the area of a given circle and that of a square of like diameter.

D is the inside diameter of the silo in feet.

H is the depth of the silage.

W is the weight per cubic foot of the silage in pounds as shown in table 1.

2000 is the number of pounds in 1 ton.

Factors which tend to increase the weight of silage somewhat are high grain content, low dry-matter content, and fine chopping; the principal factors which tend to reduce the weight are low grain content, high dry-matter content, and coarse chopping. The weight will also average somewhat greater in a silo of large diameter than in a small silo. At all events the weight of dry matter, hence the feeding value, are much less variable than the total weight and the figures given may be considered as a fair average for corn silage.

The residue remaining after either corn or hay silage has undergone an extensive loss of juice is considerably heavier than silage made from material which had sufficient dry matter to avoid such a loss but because of the low dry-matter content the feeding value is usually no greater.

In case one is dealing with a rather dry silage made from well matured corn, the data of Eckles (1) (shown in table 1, first column) for weights per cubic foot at the various levels will probably be more nearly correct than the average values given in table 3. On the other hand, in case of a noticeably wet silage such as that made from less mature corn, the data of Shepherd (2), (table 1, second column) will probably give nearer the true value for "W" in the above formula, rather than the figures shown in table 3. If the entire content of the silo is being computed from the values of table 1, it will be necessary to average all the weights per cubic foot of silage above and including the designated level to obtain the correct value for "W".

TABLE 3.—Average weights of silage summarized from table 1 applies to silage of about 31 per cent dry matter

Distance below surface of settled silage	Average weight of silage per cubic foot: Silage within indicated level only A	Average weight of silage per cubic foot: All silage above and including the indicated level B
Feet	*Pounds*	*Pounds*
1- 5	35	35
6-10	41	38
11-15	44	40
16-20	47	42
21-25	48	43
26-30	49	44
31-35 and below	50	45

The weight figures for alfalfa or clover silage of similar dry-matter content may be somewhat higher but are probably not so greatly different from the figures given for corn silage. For early cut crops which have not been wilted the Shepherd and Woodward value in table 1 should be used. Silage made largely from timothy or other relatively mature grasses tends to be considerably lighter than corn silage.

Over a period of years under most Ohio conditions corn for silage will be found to be much less variable in yield than hay crops. The quality and price of hay are even more variable than the yield. Silage quality is little affected by bad weather, and weather is responsible for most of the poor hay. An ample supply of silage which may be fed in greater or less amount, depending on the supply and price of other feeds, thus becomes almost invaluable as a buffer against excessive supply and price fluctuations of other feeds. In this connection it should be noted that silage may be carried over from one season to the next with only a minimum of deterioration and that it makes an ideal feed to supplement failing pastures so common in late summer.

Silage can be satisfactorily made from a great variety of crops and mixtures, the chief requirements being that the ensiled material be in condition to chop and pack well and that it has a suitable dry-matter content. Twenty-five to 45 per cent dry matter, or 75-55 per cent water content, represents about the desirable range; 30-35 per cent dry matter being close to the ideal condition.

The feeding value of the resulting silage is not greatly different from that of the same material if properly cured and stored in dry condition. It can never be greater than that of the material as ensiled, although the losses are usually less in silage than in dry storage. Reduction in waste at feeding time, use of the entire crop plus some weeds which seem to make acceptable feed in this form, and improvement of palatability are leading benefits obtained through use of the silo.

THE PRESERVATION AND FEEDING OF CARROTS AS COMBINATION SILAGES

A. E. PERKINS, C. C. HAYDEN, W. E. KRAUSS, R. G WASHBURN,[1] AND C. F. MONROE

Carrots are excellent feed for dairy cows and, because of their high carotene content, might be expected to maintain the yellow color in milk at a fairly high level during the winter season if fed in large enough quantities. Often lack of storage facilities eliminates the possibility of growing carrots or of using cull carrots for winter feeding. The possibility of ensiling carrots with some crop which, in itself, might make silage low in carotene suggested itself. Carrots were grown for the purpose and ensiled with overripe corn having a high percentage of dry matter and a low content of carotene. Previous work seems to be limited to a single experiment conducted at the New Jersey Agricultural Experiment Station which has been twice reported in popular form.[2, 3]

GROWING THE CARROTS

Approximately one-half acre of half-long Danvers carrots was sowed, May 7, on land which previously had been in permanent bluegrass pasture for an extended period. For three seasons previous to sowing the carrots, however, the land had been in cultivated pasture crops, Sudan grass, winter wheat, and alfalfa. The soil is classified a silt loam. It had been liberally fertilized with manure and chemicals.

This garden variety of carrots was grown in preference to the so-called "cow-carrots" because the object was to produce a feed of extra high carotene content. The garden carrots, although lower in yield, are rich in carotene; whereas the "cow-carrots" (Mangolds) are practically devoid of this yellow pigment.

Two pounds of carrot seed were sowed in rows 20 inches apart on the half acre. Turnip seed (which germinates more quickly than carrot seed) was mixed with the carrot seed in the drill in order to mark the rows and thus permit earlier cultivation of the space between the rows. This is of considerable importance since it greatly reduces the amount of hand weeding during the early part of the season. More turnip seed was used than proved desirable. It was necessary to remove most of the turnips by hand about the time of the second cultivation to avoid smothering the carrots. If turnip seed is to be used for this purpose, ½ to 1 ounce of seed per pound of carrot seed is suggested as the proper amount. In the latter part of the season considerable handwork was necessary to remove fall grasses and vining weeds.

The carrots were harvested October 3 to 5. They were loosened by means of a shovel-plow, or cultivator, then hand picked and piled with forks. The carrots as harvested were reasonably free from dirt. Both tops and roots were

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[1]On military leave.

[2]Anonymous. 1938. The relation of the feeding of corn and carrot silage to milk color. The Guernsey Breeders' Jour. 53: 10: 1077.

[3]Tucker, H. H. 1939. Improving milk color. The Guernsey Breeders' Jour. 55: 4: 279.

ensiled. The stand was estimated at about 80 per cent; the total yield from the half acre was 11,650 pounds, about 77 per cent of which was roots and 23 per cent tops. The roots contained 11.1 per cent air dry matter and the tops 20 per cent.

By combining these figures and those for the dry matter content of the roots and tops, respectively, as shown in table 1, it will be seen that approximately 987 pounds of dry matter, or 64 per cent of the total, were derived from the roots and 536 pounds, or 36 per cent of the total, from the tops.

In the common method of cellar storage of carrots the tops are removed by hand and often largely wasted. The cellar-stored roots must be protected against freezing and must usually be hand-chopped in small lots and fed separately. The large amount of hand labor involved has tended to prohibit the use of carrots as an ingredient in the practical dairy ration.

By ensiling the carrots "tops and all", along with a suitable companion crop, about 36 per cent of the dry matter of the carrot crop is saved and a great amount of hand-labor involved in storing is avoided. No protection against freezing and no separate chopping, handling, or feeding are required.

The corn ensiled with the carrots consisted of odds and ends of over-ripe corn from various sources. No separate analyses were conducted on this corn as such, though, doubtless, it was much higher in dry matter and much lower in carotene than corn which is usually ensiled.

TABLE 1.—Dry matter, pH, and carotene of carrots, corn-carrot silage, and corn silage

Date of sample	Air dry matter Per cent	pH	Carotene—(dry basis) Parts per million
	Carrots		
The tops	20.00	6.08	123.0
The roots	11.10	6.03	679.0
	Corn and carrots as ensiled		
October 5, 1938	32.5	5.80	65.8
October 5, 1938	34.0	5.83	93.5
Average	33.2	5.81	79.6
	Corn-carrot silage		
January 9, 1939	32.0	3.70	73.1
January 23, 1939	35.7	3.65	79.6
February 6, 1939	33.5	3.72	78.9
February 22, 1939	27.0	3.56	178.0
March 8, 1939	32.0	3.81	111.0
March 22, 1939	30.0	3.78	106.7
Average	31.7	3.70	104.55
	Corn silage		
Average of 6	28.5	3.68	60.73

In table 1 it will be noted that the dry matter of the silage is 1.5 per cent less than the average dry matter of the crop as ensiled. No water whatever was added in the operation. The dry matter in both crop and silage was determined by oven drying. Since this work was done, it has been shown by one of us[4] that apparent losses of dry matter of about this magnitude frequently occur in silage studies. They were shown to be due to the formation of volatile products during silage making which are driven off when the silage is dried and hence are included with water in the usual method of dry matter determination.

CORN-CARROT SILAGE

When the carrots were harvested they were piled near the silage cutter and forked into it, along with the corn, at as nearly a uniform rate as possible. About 1 ton of carrots was used for each 2.25 tons of corn. The top of the silage was covered with a small load of chopped weedy corn.

The silo was opened 2 months after filling. The silage was found to be in good physical condition with a pleasant silage odor, and it was found to have an acidity (pH 3.70) comparable to that commonly found in corn silage. It is felt, however, that the corn used was too dry and weathered for best results and that corn in the condition it is usually harvested for grain would have been preferable and would have given an even better silage when mixed with the carrots. Contrary to what might have been expected, the pieces of chopped carrots retained what appeared to be their original physical condition. The dry matter, pH, and carotene content of the silage are shown in table 1.

Table 1 shows that the carotene content of the roots was very high and that the carotene was much higher in the lower part of the silo.

FEEDING

The two groups of cows used in the feeding test were fed in alternate periods. Preliminary data on the cows are given in table 2. The cows were weighed on two successive days at the beginning and close of each feeding period.

TABLE 2.—Preliminary data on cows selected

Group 1			Group 2		
Cows	Daily milk	Live-weight	Cows	Daily milk	Live-weight
	Lb.	*Lb.*		*Lb.*	*Lb.*
508 H. F.*	32.6	1424	352 H. F.	20.2	1209
500 H. F.	28.1	1400	486 H. F.	23.0	1430
			524 H. F.	21.8	1248
453 J.†	24.0	889			
518 J.	18.9	896	477 J.	21.1	943

*H. F. Holstein-Friesian.
†J. Jersey.

[4]Perkins, A. E. 1943. Losses in silage making. Ohio Agr. Exp. Sta. Bimo. Bull. 28: 220: 32-34. Also Jour. Dairy Sci. 1943. 26: 545.

All cows were on a like ration during the month preceding the test.

The grain mixture fed to both groups of cows consisted of 4 parts of ground corn, 3 parts ground oats, and 1 part each of wheat bran and linseed oil meal. This grain was fed to both groups at the rate of 1 pound of grain to 3 pounds of milk produced by Jerseys and to 4 pounds of milk produced by Holsteins. Alfalfa hay was fed to both groups at the rate of about 1 pound to each 100 pounds of liveweight. An attempt was made to feed the corn silage and the corn-carrot silage, which were being compared, in quantities which would give equal amounts of dry matter and at the same time take into consideration the capacity of the cows. These two objects were not exactly accomplished. The amount of silage fed daily averaged about 40 pounds.

The ordinary corn silage was fed to the experimental animals for a period of 46 days and the corn-carrot silage for only 40 days before the groups were reversed. After reversal both groups were continued on the experimental feeding for 46 days. The data presented are based on the feeding and production records of the last 40 days in each period.

The results of feeding are summarized in table 3.

TABLE 3.—Milk and fat production, feed consumption, and changes in liveweight

	40 days on corn silage	40 days on corn-carrot silage	Difference
	Lb.	*Lb.*	*Lb.*
Milk produced	7257.1	7287.5	+ 29.0
Fat produced	328.7	326.6	— 2.1
4 per cent milk produced	7834.7	7844.4	+ 9.7
Grain consumed	2266	2208	— 58
Hay consumed	3783	3778	— 5
Silage consumed	13146	12656	—490
Dry matter in silage	3744	4017	+273
Gain in weight	289	207	— 32
Lost weight	1 cow	1 cow	....

The milk and butterfat production on the two rations were almost identical, and, since the feed intake was controlled, it can be concluded that the two silages were of practically equal value for milk production. The cows receiving corn silage gained a little more in weight. It is possible that the more mature corn used with the carrots may have had some effect. Samples of milk were collected at the beginning and end of each feeding period and the carotene content of the butterfat determined. The results are shown in table 4.

TABLE 4.—Change in carotene content of butterfat on corn silage and corn-carrot silage rations

Group 1	Carotene in butterfat	Group 2	Carotene in butterfat
	Parts per million		*Parts per million*
Beginning	4.18	Beginning	4.13
Corn silage period	3.96	Corn-carrot silage period	4.95
Corn-carrot silage period	5.20	Corn silage period	4.86

More carotene; i. e., greater depth of yellow color, was found in the fat from the cows while they were being fed corn-carrot silage. This is in keeping with the carotene content of the silage. The corn silage contained 54.3 and 80.4 parts of carotene (oven dry basis) during the first and second periods, respectively, and the corn-carrot silage 76.9 and 108.9 parts per million during comparable periods. The difference in carotene content of the butterfat was more marked when the feeding was changed from corn silage to corn-carrot silage than when the opposite change was made, indicating a carry-over effect of the higher carotene feeding. Since the corn-carrot silage contained about 30 per cent carrots, the average daily feeding of 40 pounds contained about 12 pounds of carrots. Because the observed increase of carotene in the product was definite but not of high order, it can be assumed that approximately 12 pounds of carrots per day are needed to accomplish any considerable increase in the carotene production of dairy cows when compared with the production on the relatively carotene-rich basal ration of corn silage and alfalfa hay. However, compared with many common rations which have a lower carotene content, the effect would likely have been much more marked. In such a case, also, a smaller feeding of carrots would doubtless have served to produce an evident effect.

ALFALFA-CARROT SILAGE

A second, smaller silo was filled with the carrots in mixture with fresh-cut green alfalfa. The silage, upon opening about 2 months later, seemed rather wet but was judged to be of good quality and was highly palatable to the cows. The individual pieces of carrots seemed to be softened to a greater extent than those ensiled in mixtures with corn. Probably the quality would have been improved by wilting the alfalfa somewhat before ensiling. However, the silage was not available in sufficient amount to permit a feeding comparison such as was conducted with the corn-carrot silage. As shown in table 5, the carotene was present in liberal amount and was well preserved in the silage.

TABLE 5.—Analyses of alfalfa-carrot silage

Material	Dry matter	pH	Carotene (dry basis)
	Per cent		*Parts per million*
Mixed crops as ensiled	30.7	5.78	257.3
Silage, average result	27.2	4.36	255.9

SUMMARY

Carrots were grown and successfully ensiled in mixture both with over-ripe corn and green alfalfa. The tops as well as the roots of the carrots were ensiled, thereby saving much labor and at least one-third of the dry matter of the carrots over the usual method of storage. The silages containing the carrots were highly palatable to the cows, gave good returns in milk and fat production, and exerted a positive but small favorable effect on the yellow color (carotene content) of the milk and butterfat produced.

FAT IN THE DAIRY GRAIN MIXTURE

C. F. MONROE AND W. E. KRAUSS

New developments in methods of extraction enable processors to remove more completely the oil from seeds than when the older methods are used. This means that the by-product oil meal resulting from the new process is extremely low in oil or fat. When such meals are used in grain mixtures they reduce the fat content of the resulting mixture as compared with that found in mixtures prepared from oil meals produced by the older processes. The question may be raised as to the effect of feeding low-fat or high-fat protein supplements, or, more specifically, the effect of the level of fat in grain mixtures on milk production. In order to answer this question, under conditions existing in this State, the experiments herein described were undertaken.

EXPERIMENTAL PROCEDURE

The general plan followed in these trials has been to conform as nearly as possible to practical conditions in the feeding and management of the cows. Specifically this has meant the feeding of liberal amounts of legume and legume-mixed hay, along with moderate amounts of corn silage as the roughage portion of the ration. A grain mixture suitable for feeding with these roughages was fed according to milk production. In keeping with the general plan, the experimental feeding was continued long enough to permit the animals to become well adjusted, if possible, to the rations. Thus, the actual feeding of the experimental grain mixtures was continued for 110 days in one series of trials and 100 days in another series.

Five different feeding trials were conducted. These were all similar in plan, with some minor exceptions that will be pointed out. The continuous type of feeding trial was used throughout; that is, the animals were fed the experimental rations continuously for an extended period of time. Preceding the experimental feeding the cows were all fed the same ration and then later were arranged into comparable groups according to their production in this preliminary or basal period. This type of trial was used in preference to the reversal trial, because it permits of longer feeding periods. The continuous type trial requires more animals than the reversal type, because a cow receives only one experimental ration; whereas in the reversal trial each cow may receive two or three experimental rations for short periods of time. Since the large herd of Holstein cows located at Grafton State Farm was made available for this work by the State Department of Public Welfare,[1] groups of cows adequate in number for the continuous-type trial were obtained. Four of the five

[1]The authors are grateful to the Ohio Department of Public Welfare and to its chief agriculturist, Mr. J. D. Bragg, for permission to use the Grafton State herd for this work. Appreciation is also due the officials of the Grafton State Farm for their cooperation and assistance; these men are Mr. A. L. Glattke, superintendent of the Ohio State Reformatory of which the Grafton State Farm is a subsidiary, Mr. J. H. Reynard, farm superintendent, and Mr. W. C. Fishburn, dairy herdsman. Special credit goes to Mr. E. G. Crago, the Experiment Station representative who resided at the farm and had direct charge of the work.

trials were conducted with the Grafton institution herd under the supervision of an Experiment Station employee residing at the farm. The fifth trial[2] was carried out with a group of cows at the Experiment Station at Wooster.

FIRST YEAR'S TRIALS

Three grain mixtures representing three different levels of fat were compared in two trials conducted the first year. The formulas for these mixtures are shown in table 1. In general, the grain mixtures were nearly identical except for the protein supplement used in them. The high-fat mixture, averaging 4.73 per cent fat, contained as protein supplements ground soybeans, expeller soybean oil meal, and a very small amount of linseed oil meal; the medium, or 3.54 per cent mixture, contained only expeller soybean oil meal; and the low-fat mixture contained only extracted soybean oil meal and averaged 2.69 per cent fat. The comparison of these grain mixtures amounts to a comparison of the different protein supplements, as well as the different fat levels of the total mixtures. Actually, the protein supplements are compared on the basis of the total amount of protein furnished rather than on an equal weight basis. To equalize the protein content of mixtures slight adjustments in the amounts of ground corn and wheat bran were necessary. The experimental differences between the grain mixtures are shown in tabular form in table 1A. The mixtures here shown may be considered as "experimental supplements", or the points of difference between the grain mixtures as fed in trials 1 and 2. With the exception of the experimental supplements shown in table 1A the grain mixtures were identical, as was the treatment of the cows in the different groups.

The high-fat grain mixture was fed to all the cows for the preliminary period of 50 days. Near the end of this time, the animals were matched into sets of three, as nearly alike as possible. A member of each set was then assigned to one of three groupings. Experimental grain mixtures were then alloted to three groupings by having someone draw numbers from a hat. This same procedure was followed in all five of the trials. It was hoped by this method to obtain well balanced groups and, at the same time, to give each fat level represented by the different grain mixtures an equal chance.

After the preliminary feeding period, the groups selected to receive the medium- and low-fat grain mixtures were started on a half portion of these mixtures, along with a half portion of the high-fat mixture. This blended feeding, designed to give a gradual change, was continued for 5 days and then the medium- and low-fat mixtures were fed straight. The groups selected to receive the high-fat grain mixture were continued without change as this mixture was the same as that fed in the preliminary period. This transition period took 10 days and the data from it are not considered in the final results. The experimental data are based on 100 days of actual feeding of the grain mixtures compared.

[2]Credit also goes to Mr. C. E. Knoop, dairy herdsman at the Experiment Station, who supervised the work done in the Station's herd.

The work was made possible by a Fellowship granted by the Central Soya Company, Inc., Fort Wayne, Indiana.

TABLE 1.—Grain mixtures used in trials 1 and 2, with average protein and fat in percentages

	High fat	Medium fat	Low fat
	Lb.	*Lb.*	*Lb.*
Corn-and-cob meal	800	800	820
Ground oats	350	350	350
Wheat bran	250	300	300
Molasses feed*	300	300	300
Linseed oil meal	50	....	....
Ground soybeans	200	....	....
41 per cent (expeller) soybean oil meal	....	200	....
44 per cent (browned extracted) soybean oil meal	....	....	180
Minerals and salt†	50	50	50
Total	2,000	2,000	2,000
Total protein:			
First experiment, per cent	15.19	15.78	16.07
Second experiment, per cent	15.94	15.50	15.63
Average, per cent	15.57	15.64	15.85
Total fat:			
First experiment, per cent	4.69	3.42	2.79
Second experiment, per cent	4.77	3.65	2.58
Average, per cent	4.73	3.54	2.69

*Composed of 53 per cent soybean oil meal, 27 per cent molasses, and 20 per cent dried beet pulp. In the high- and medium-fat mixtures 41 per cent (expeller) soybean oil meal was used, and in the low-fat mixture, 44 per cent browned extracted soybean oil meal was used.

†Minerals and salt. 50 pounds per ton of feed mixture composed of salt 20 pounds, steamed bone meal 20 pounds, and finely ground limestone 10 pounds.

TABLE 1A.—Experimental differences in the grain mixtures shown in table 1

	High fat	Medium fat	Low fat
	Lb.	*Lb.*	*Lb.*
Corn-and-cob meal	....	....	20
Wheat bran	....	50	50
Linseed oil meal	50	....	....
Ground soybeans	200	....	....
41 per cent (expeller) soybean oil meal*	159	359	....
44 per cent (browned extracted) soybean oil meal	....	....	339
Total	409	409	409

*See footnote on table 1 for explanation on the soybean oil meals.

With the exception of feeding the different grain mixtures, the remainder of the feeding was similar for all the animals. Hay was fed in ample amount so that the cows had all they wanted to eat. It generally consisted of a mixture of alfalfa and timothy, with some clover; sometimes the quality was not too good.

Corn silage was also fed, except for the preliminary period of the first trial, when a meadow crop or hay silage was fed. The amounts of silage were limited to 30 pounds daily for each cow.

Butterfat tests were made on a day's milk production from each cow two times per month.

RESULTS—TRIALS 1 AND 2 COMBINED

(Fat Percentages in the Grain Mixtures Compared— High-fat, 4.73; Medium-fat, 3.54; Low-fat, 2.69)

For the sake of brevity, the results of the first two trials are considered as one trial, since they were conducted in the same manner with similar grain mixtures. The chief differences between these trials lay in the use of different cows and in the different periods in the barn feeding season. Although the same kinds of feeds were used in each trial, the feeds were not from the same lots.

The results of the two trials were in close agreement and the combined data are shown in table 2. All the figures in the table have been reduced to a 30-day average per-cow basis. These averages were obtained from 70 animals, 25 of which were in the high-fat group, 25 in the low-fat group, and 20 in the medium-fat group.

As shown in table 2 the productions of the three groups were very similar during the experimental period. The small differences, even if they could be attributed to the feeding, appear to be of little consequence. Thus, on the 30-day basis, the maximum differences between the groups amounted to 3.5 pounds of milk, 0.7 pound of butterfat, 0.06 per cent in butterfat test, 11.1 pounds of 4 per cent milk,[3] and 2.3 pounds of liveweight gain.

When the results of the experimental period are compared with those obtained in the preliminary period, when all the groups were fed alike, it is even more evident that lowering the fat intake made little difference in production. The differences between the groups were in general a little greater when the same grain mixture was fed than when different mixtures were used, as in the experimental period. Thus, group 1 averaged 22 pounds more of 4 per cent milk in the preliminary period than group 3. During the experimental period, when these groups received the high- and low-fat grain mixtures, respectively, the difference between them was reduced to 8 pounds. This comparative relationship, based on the production of 4 per cent milk in the preliminary and experimental periods, is expressed in the form of percentages and is shown in the last line of table 2. These percentage productions were as follows: High-fat, 82.76; medium-fat, 82.44; and low-fat, 83.68. The figures indicate no greater differences than would be normally expected from feeding the same ration or fat level to all three groups of cows.

The butterfat tests were not influenced by the fat content of the grain mixtures fed. All three groups tested about the same in the preliminary period and experienced about the same increase in test during the experimental period, regardless of the difference in their fat intake. These increases, in terms of test percentages, ranged as follows: High-fat, 0.11; medium-fat, 0.12; and low-fat, 0.15. Such increases may be considered as normal for the advance in lactation covered during the period.

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[3] 4 per cent (Fat corrected milk) = .4 × milk + 15 × fat

By this method milk and butterfat productions can be expressed in a single figure.

Example: A monthly production of 1200 pounds of milk testing 3.3 per cent and yielding 39.6 pounds of butterfat would be converted into 4 per cent (F. C. M.) as follows:

1200 pounds of milk	× .4	=	480.0 pounds
39.6 pounds of butterfat	× 15	=	594.0 pounds
4 per cent (F. C. M.)		=	1074.0 pounds

TABLE 2.—TRIALS 1 AND 2 COMBINED.—Summary of milk and butterfat production and liveweight gains, with feed consumption

(During a preliminary period of 50 days, all cows were fed the high-fat ration containing 4.73 per cent fat)

	Group 1	Group 2	Group 3
Preliminary period, 50 days			
Number of cows	25	20	25
Production per cow, 30 days			
Milk, lb	1,265.50	1,272.10	1,257.50
Test, per cent	3.26	3.19	3.19
Fat, lb	41.30	40.60	40.10
Milk (4 per cent F. C. M.) lb	1,126.20	1,117.30	1,104.10
Grain fed (30 days), lb	404.00	413.90	411.30
Milk per lb. of grain, lb	3.13	3.07	3.06
Liveweight gain per cow, 30 days, lb	17.10	15.80	17.80
Average daily 4 per cent milk per cow, lb	37.50	37.20	36.80
Experimental period, 100 days			
	High fat	Medium fat	Low fat
Number of cows	25	20	25
Fat in grain mixture, per cent	4.73	3.54	2.69
Production per cow, 30 days			
Milk, lb	1,030.10	1,028.30	1,026.60
Test, per cent	3.37	3.31	3.34
Fat, lb	34.70	34.00	34.30
Milk (4 per cent F. C. M.), lb	932.10	921.10	923.90
Grain fed (30 days) lb	340.50	334.30	328.30
Milk per lb. of grain, lb	3.03	3.08	3.13
Liveweight gain per cow, 30 days, lb	21.80	19.80	19.50
Average daily 4 per cent milk per cow, lb	31.10	30.70	30.80
Difference between periods			
Milk, lb	—235.40	—244.00	—230.00
Test, per cent	+ 0.11	+ 0.12	+ 0.15
Fat, lb	— 6.60	— 6.60	— 5.80
4 per cent milk, lb	—194.10	—196.20	—180.20
Grain, lb	— 63.50	— 79.60	— 83.00
Milk per lb. of grain, lb	— 0.10	+ 0.01	+ 0.07
Liveweight gain, lb	+ 4.70	+ 4.00	+ 1.70
Average daily 4 per cent milk per cow, lb	— 6.40	— 6.50	— 6.00
Ratio of experimental : preliminary, per cent	82.76	82.44	83.68

SECOND YEAR'S WORK

In the second year only two grain mixtures were compared. These represented a moderately high fat level of 4.89 per cent and a fairly low level of 3.19 per cent. For the high-fat mixture a combination of expeller soybean oil meal and ground soybeans was used as the protein supplement; whereas in the low-fat mixture extracted soybean oil meal was substituted for this combination. With the exception of these differences and a very small difference in the amount of ground shelled corn, the two grain mixtures were identical. The grain mixtures are given in table 3 and the experimental differences between them are shown in table 3A.

During the second year, the three trials followed the general pattern of those described for the first year, with a few minor exceptions.

The grain mixture fed during the preliminary periods of these three trials was made up of a 50-50 blend of the grain mixtures as fed during the experimental periods. This blended mixture was fed for 10 days previous to the start of the preliminary period when the cows were weighed. The animals were then continued for 30 days on the blended ration, after which they were paired off and arranged into groups; then they were immediately started on the experimental grain mixtures. In this way there was no transitional feeding between the two periods. The experimental grain mixtures were fed for 100 days, the first ten of which are not considered in the calculations, leaving net experimental periods of 90 days each. The sudden change in feeding as here described was accomplished without causing any noticeable disturbance to the cows. Although the change was a sudden one, it was not drastic for either group because of the previous feeding of the blended grain mixture.

The feeding periods, as given above, differ from those of the first year's work in being 20 days shorter for the preliminary period and 10 days shorter for the experimental period.

The butterfat tests in this second year were made more often than in the previous work, as composite samples of a day's production were tested every 10 days, as compared to two times every 30 days in the former work.

RESULTS—TRIALS 3, 4, AND 5

(Fat Percentages in Grain Mixtures Compared Were: High-fat Mixture, 4.89 and Low-fat Mixture, 3.19)

In this second series of trials there was a total of 58 cows involved. These were all Holsteins, with the exception of six Jerseys that were a part of the group in the trial conducted at the Experiment Station at Wooster. As in the year previous, two tests were run at the Grafton State Farm with a man from the Experiment Station supervising the work.

The one trial conducted with the Station herd was regarded as a check test for those conducted with the Grafton herd. In this check trial, the procedure was the same as in the other two trials of the year, except that it involved the use of a different herd of cows and feeds from different lots. The results obtained in this check trial agreed with those obtained with the Grafton herd. For the sake of brevity, the three trials are here reported as one trial and the combined summaries are given in table 4. The story is about the same as that of the previous year.

During the preliminary period when the blended grain mixture was fed to both groups of cows, group 1 gave 22 pounds more milk but only 0.6 pound more butterfat than group 2, the latter group testing slightly higher. The 30-day average for the two groups, as expressed in terms of 4 per cent milk, was 1200.4 pounds for group 1 and 1181.6 pounds for group 2, a difference of about 19 pounds. Both groups gained in liveweight, the gains averaging 15 pounds for group 1 and 25 pounds for group 2.

The results obtained by feeding the two groups on different fat levels show that the relationships described for the preliminary feeding period continued with practically no change. Thus, group 1 on the high-fat grain produced 38 pounds more milk but made slightly less butterfat than group 2

which was on the low-fat ration; the latter group again tested slightly higher. The production of 4 per cent milk was 1077.5 pounds for group 1 and 1054.3 pounds for group 2, or a 23-pound advantage in the preliminary period. Expressed in percentages, the high-fat group gave 89.76 per cent as much 4 per cent milk during the experimental period as it did in the preliminary period; whereas this figure for the low-fat group was 89.23 per cent. This is a small difference and is not significant.

TABLE 3.—Grain mixtures used in trials 3, 4, and 5

(Average protein and fat in percentages)

	High fat	Low fat
	Lb.	*Lb.*
Corn-and-cob meal*	850	910
Ground oats	340	340
Wheat bran	200	200
Molasses feed†	250	250
Ground soybeans	120	...
41 per cent (expeller) soybean oil meal	200	...
44 per cent (extracted) soybean oil meal	...	260
Minerals and salt‡	40	40
Total	2,000	2,000
Total protein:		
Trial 3, per cent	17.90	18.03
Trial 4, per cent	18.11	18.00
Trial 5, per cent	16.78	17.78
Average, per cent	17.60	17.94
Total fat:		
Trial 3, per cent	4.83	3.21
Trial 4, per cent	4.86	3.12
Trial 5, per cent	4.99	3.24
Average, per cent	4.89	3.19

Roughages:

First- and second-cutting alfalfa hay fed *ad libitum*; records of consumption kept in trial 5; corn silage, 30 pounds per day to Holstein cows and 26 to 28 pounds to Jerseys (amounts weighed).

*Ground corn was used in place of corn-and-cob meal in trial 5.

†See table 1 footnote.

‡Minerals and salt, 40 pounds per ton of feed mixture, composed of salt 20 pounds and dicalcium phosphate 20 pounds for trials 3 and 4. In trial 5 steamed bone meal replaced the dicalcium phosphate.

TABLE 3A.—Experimental difference in the grain mixture shown in table 3

	High fat	Low fat
	Lb.	*Lb.*
Corn-and-cob meal	...	60
Ground soybeans	120	...
41 per cent (expeller) soybean oil meal	332	...
44 per cent (browned extracted) soybean oil meal	...	392
Total differences	452	452

The butterfat tests were little, if any, influenced by the level of fat feeding. Group 2 tested higher than group 1 in both periods. In the preliminary period the difference was 0.02 per cent and in the experimental period 0.07 per cent. Each group tested about the same in both periods; thus, for group 1 the

average butterfat test in the preliminary period was 3.55 per cent as compared to 3.53 per cent on the high-fat ration; for group 2 the tests were 3.57 as compared to 3.60 per cent on the low-fat ration.

In the matter of liveweight gains also the difference between the groups was too small to be of significance. On the high-fat ration the average gain was 16 pounds and on the low-fat ration the gain was 13 pounds.

TABLE 4.—TRIALS 3, 4, AND 5 COMBINED.—Summary of milk and butterfat production and liveweight gains, with feed consumption

(During a preliminary period of 30 days, all cows were fed a blended ration containing 3.95 per cent fat)

	Group 1	Group 2
(Preliminary period, 30 days)		
Number of cows	29	29
Production per cow, 30 days		
Milk, lb	1,286.10	1,264.80
Test, per cent	3.55	3.57
Fat, lb	45.70	45.10
Milk (4 per cent F. C. M.), lb	1,200.40	1,181.60
Grain fed (30 days)	376.00	367.80
Milk per lb. of grain, lb	3.42	3.44
Liveweight gain per cow, 30 days, lb	15.40	24.50
Average daily 4 per cent milk per cow, lb	40.01	39.39
(Experimental period, 90 days)		
	High fat	Low fat
Fat in grain mixture, per cent	4.89	3.19
Number of cows	29	29
Production per cow, 30 days		
Milk, lb	1,159.10	1,121.30
Test, per cent	3.53	3.60
Fat, lb	40.90	40.40
Milk (4 per cent F. C. M.), lb	1,077.50	1,054.30
Grain fed (30 days), lb	374.40	356.60
Milk per lb. of grain, lb	3.09	3.14
Liveweight gain per cow, 30 days, lb	16.20	13.00
Average daily 4 per cent milk per cow, lb	35.92	35.14
(Differences between periods)		
Milk, lb	—127.00	—143.50
Test, per cent	— 0.02	+ 0.03
Fat, lb	— 4.80	— 4.70
4 per cent milk, lb	—122.90	—127.30
Grain, lb	- 1.60	— 11.20
Milk per lb. of grain, lb	— 0.33	— 0.30
Liveweight gain, lb	+ 0.80	— 11.50
Average daily 4 per cent milk per cow, lb	— 4.09	— 4.25
Ratio of experimental : preliminary, per cent	89.76	89.23

COMPARISON OF PAIR-MATES

For this study the experimental production, in terms of 4 per cent milk, for each cow was divided by the corresponding production in the preliminary period. The ratio or percentage thus obtained for each cow was compared with the similar figure for her pair mate on the other fat level. Of the first year's trials, the cows fed the medium-fat level have been omitted and the comparison made between the animals on the high- and low-fat rations. There were twenty-five such pairs. In thirteen of these pairs, the cow receiving the

high-fat ration had a higher ratio than her low-fat pair mate; but, in eleven pairs, the reverse of this was true; and, in one pair, the ratios were "even-up". This story is duplicated in the second year's work, in which twenty-nine pairs were involved. There were fifteen pairs in which the cow on the high-fat intake had a higher ratio than her pair mate on the low-fat intake. Opposed to this were thirteen pairs in which the low-fat pair mate was ahead. Again there was one pair having identical ratios. A total of 54 pairs was used during the two years' work; of these 28 favored the high-fat intake. This represents one more than half the number involved. Without any difference in feeding it could be expected that the pairs would be about equally divided. Hence, this study of the performance of the individual cows confirms the results derived from the study of the group totals.

TABLE 5.—Comparison of pairs in the two years' work

	Number pairs	Favored high-fat	Favored low-fat	Equal ratios
First year	25	13	11	1
Second year	29	15	13	1
Total	54	28	24	2

CALVING DATA

During the first year's work with the Grafton herd the dry cows were fed the experimental grain mixtures, as listed in table 1, practically up to freshening time. There appeared to be no consistent difference in the condition of the groups at freshening nor in the health or vigor of the new-born calves. The birthweight and height at the withers of fifty-three calves, as shown in table 6, indicate that normal calves were produced on all three levels of fat feeding and that the averages for the birthweights and height at withers were nearly the same in all three groups of calves.

TABLE 6.—Birthweight and height at withers of calves dropped on the three rations—averages

Ration	Males			Females		
	Calves	Weight	Height	Calves	Weight	Height
	No.	*Lb.*	*In.*	*No.*	*Lb.*	*In.*
High-fat	15	106.3	30.6	11	97.8	29.9
Medium-fat	6	108.5	31.1	8	104.4	30.7
Low-fat	10	108.8	31.0	3	104.0	30.3

DISCUSSION

The results obtained in these five comparisons show that under the conditions existing in this work the varying amounts of fat supplied in the grain mixtures gave no significant differences in milk or butterfat production. Furthermore, the butterfat tests and liveweight gains of the cows were similar on the different fat intakes. Likewise, the general condition and health history of the animals were much the same on the different rations. There was no evidence shown that the fat intake had any influence on the udder itself, either by causing or preventing any trouble. In the feeding work of the first year in which the experimental grain mixtures were given to the dry cows for some time previous to freshening, it was shown that new-born calves from the three groups were about equal in birthweight and skeletal development as measured by the height at the withers. All this work may be briefly summed up by saying that the differences between the fat content of the grain mixtures here compared had no effect on how the cows ate the mixtures or produced on them.

PRACTICAL APPLICATION

Thus far in this discussion the chief consideration has been given to the differences in the fat content of the grain mixtures compared. But since these various levels of fat were obtained by using different protein supplements, or mixtures thereof, the work may also be regarded as a comparison of protein supplements. These supplemental differences are shown in table 1A for the first year's work and table 3A for the second year's trial. In these tables are shown the total differences between the grain mixtures, including the small amount of feeds necessary to adjust the mixtures to an approximate equivalent protein content. For the trials of the first year the total experimental differences between the grain mixtures amounted to approximately 20.5 per cent of the entire mixture. Of this portion, one mixture included 10 per cent ground soybeans and 8 per cent expeller soybean meal; the second included 18 per cent expeller soybean oil meal, and the third 17 per cent extracted soybean oil meal. The fractions unaccounted for consisted of the adjustments referred to above.

In the second year's work the experimental differences amounted to 22.5 per cent of the totals. In the one grain mixture there were 16.5 per cent expeller soybean oil meal and 6 per cent ground soybeans; whereas in the other grain mixture there was 19.5 per cent extracted soybean oil meal, with a 3 per cent adjustment of ground shelled corn.

As the results of this work showed the grain mixtures to be approximately equal, it must be concluded that the different protein supplements had about equal values, on a protein basis. This means that these supplements are interchangeable when adjustments are made for their protein content. Thus, in the first year's work the results indicated that the extracted soybean oil

meal could be substituted for expeller meal or a mixture of this latter meal and ground soybeans. In the second year's work the extracted meal was substituted for the expeller soybean oil meal supplemented with a small amount of ground soybeans. In all cases, the substitution was on the basis of the amount of protein furnished, rather than on a strictly weight basis, or pound for pound.

CONCLUSION

Under the conditions of these trials no significant differences were observed in the production of milk, butterfat, or 4 per cent milk (F. C. M.), butterfat percentage of milk produced, liveweight gains, or in the general health of milking cows from the feeding of practical grain mixtures ranging in their average fat percentage from 4.89 to 2.69.

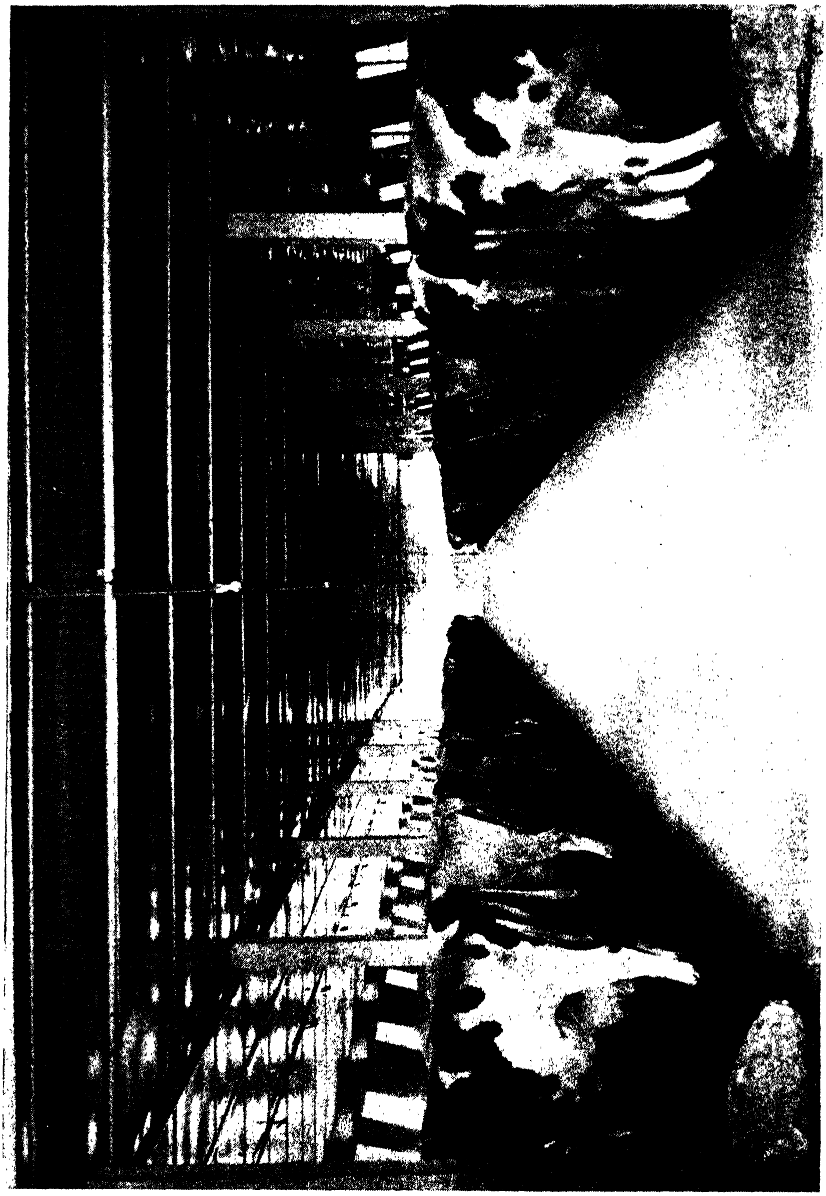

Fig. 1.—Interior of the dairy barn at the Grafton State Farm, showing cows used in four of the five trials

CALCIUM FOR EGG SHELLS

D. C. KENNARD

Egg producers face a new wartime feeding problem—a suitable source of calcium or lime in the form of calcium carbonate for egg shell formation. Oyster shell, which has been extensively used for feeding layers, has become scarce in some localities so that many layers have been denied this essential part of their ration. Limestone grit, containing 90 per cent or more of calcium carbonate, is the best known available substitute for oyster shell. Unfortunately, there is little or no 90 per cent or more calcium carbonate limestone grit available locally for poultry feeding in many sections of the country, including Ohio.

Dolomitic or magnesia limestone is available almost everywhere but unfortunately it is ill suited for feeding poultry. However, the shortage of oyster shell or limestone grit of poultry-feeding grade may force many poultrymen to resort to the use of magnesia limestone.

The purpose of this discussion is to emphasize the importance of oyster shell or calcium carbonate grit[1] in the ration for layers and to familiarize poultrymen and feed merchants with the liabilities that attend the use of dolomitic or magnesia limestone.

Various experiment stations (California, Iowa, Kentucky, Maryland, and Utah) have conducted experiments comparing oyster shell with calcium carbonate limestone grit. Their reports conclusively indicate that comparable results in egg production can be secured from either oyster shell or calcium carbonate (calcite, crystal, gray, or blue) limestone grit when fed to layers. Contrary to this, the use of dolomitic or magnesia limestone by the New York, Ohio, Utah, and Wisconsin Stations invariably resulted in failure.

In 1919, Wheeler[2] of the Geneva, New York, Station stated, "The functions of calcium are very important and some of them are directly antagonistic to those of magnesium, the nearest to calcium chemically of the recognized elements of the body and of ordinary foods. But the two elements are associated in nature in many ways, and magnesium seemingly might serve to some extent in place of calcium for such purposes as egg-shell material when calcium is lacking. No instance was found where magnesium did this to any significant extent, or replaced calcium in the bones from which it was withdrawn for shell material, although both elements are normal constituents of these structures."

Halpin and Hayes[3] of Wisconsin reported three tests in 1922 in which much better egg production was secured from hens receiving oyster shell than from those receiving limestone grit relatively high in its percentage of magnesium.

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[1]Limestone grit must contain 90 per cent or more of calcium carbonate to be considered of poultry-feeding grade. Unless otherwise stated this grade of calcium carbonate limestone grit will be referred to in this paper, and for the sake of brevity the percentages of calcium carbonate will be omitted in the text hereafter.

[2]Wheeler, W. P. 1919. New York Agr. Exp. Sta. Bull. 468.

[3]Halpin, J. G., and J. B. Hayes. 1922. The feeding for eggs. Wis. Ext. Service Circular 141.

Alder[4] of Utah reported in 1927 an experiment in which he states: "It was necessary to discontinue the feeding of limestone high in magnesium content to layers because of the unfavorable results on the health of the birds. Towards the end of four months, during which time the layers received dolomitic limestone, the pullets became extremely nervous, very sensitive and easily frightened, and their egg production decreased with the shells of the eggs becoming progressively thinner. Practically every bird in the pen had developed diarrhea. All these symptoms cleared up in a short time after substituting a practically pure calcium (blue) limestone. Contrary to the ill effect upon the layers which received the dolomitic magnesium limestone grit in this experiment, the calcite (99 per cent calcium carbonate) limestone grit fed another group of layers proved as satisfactory as oyster shell."

OHIO EXPERIMENTS WITH CALCIUM CARBONATE SUPPLEMENTS FOR LAYERS

RATIONS AND PROCEDURE

The basal ration used during the two years' experiments at Ohio was:

Whole grain mixture—corn 3 parts, wheat 2 parts
Mash—ground corn 2 parts, wheat middlings 2 parts, meat scraps, 1 part (50% protein)
Green feed—cabbage or sprouted oats, November to March

TABLE 1.—Egg production, feed, oyster shell, and grit consumption

Oyster shell and grit supplements to basal ration	Experiment No.	Eggs* per bird	Consumption of feed, oyster shell and grit per bird†					
			Whole grain	Mash	Total feed	Oyster shell	Magnesia limestone grit	Mica grit
		No.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Oyster shell and mica grit	1	137	46.93	31.64	78.57	2.22	....	1.45
	2	159	46.91	34.33	81.24	3.50	....	0.80
	Av.	143	46.92	32.98	79.90	2.86	....	1.12
Dolomitic magnesia limestone grit	1	122	51.09	27.00	78.09	......	3.29	... .
	2	125	45.64	30.83	76.47	....	1.62	....
	Av.	123	48.36	28.91	77.28	....	2.45	....
Oyster shell and dolomitic magnesia limestone grit	1	144	50.01	31.76	81.77	1.84	0.59	....
	2	147	47.48	35.83	83.31	2.84	0.84	....
	Av.	145	48.74	33.79	82.54	2.34	0.71	....
Mica grit	1	100	46.67	29.65	76.32	....	....	7.16
	2	103	44.15	29.42	73.57	....	....	3.37
	Av.	101	45.41	29.53	74.94	....	....	5.26

*On basis of trapnest egg records of birds completing experiments.
†On basis of hen days.

[4]Alder, Byron. 1927. World's Poultry Congress Report, Ottawa, Canada. 231-234.

Theoretically, the grain and mash were supposed to be fed in equal amounts; actually, the grain consumption considerably exceeded that of the mash, as indicated in table 1. This ration was in common use 20 to 25 years ago, before the introduction of vitamin supplements such as alfalfa, milk by-products, and vitamin A and D feeding oils or other vitamin D supplements. Under wartime feed conditions, poultry keepers are finding it necessary to use somewhat similar simplified rations in many instances. Without the vitamin supplements, now known to be necessary for layers confined indoors or for winter egg production, as might be expected, the winter egg production (October 10 to March 1) from any of the groups in either experiment did not exceed 25 per cent.

Both experiments were conducted for 12 months (October 12, 1922 to October 10, 1923 and October 11, 1923 to October 8, 1924) with four groups, each consisting of 30 range-raised, ready-to-lay Barred Plymouth Rock pullets. The pullets were trapnested and the egg production was calculated on the basis of the birds completing the experiment.

DISCUSSION OF RESULTS AND APPLICATIONS

The groups which received oyster shell averaged 20 more eggs per bird (table 1) than did those that received dolomitic magnesia limestone grit (80 per cent calcium carbonate) and 42 more eggs per bird than the groups that received no calcium carbonate supplement for egg-shell formation. It should be emphasized here that the dolomitic magnesia limestone grit used in these experiments by the Ohio Station was of a higher quality and contained more calcium and less magnesium than many grades of limestone which are available and may be used for poultry feeding. Obviously, the use of lower grades of magnesia limestone may be attended by far greater ill effects, as experienced in the experiments conducted by the Utah Agricultural Experiment Station to which previous reference has been made. The groups which received both oyster shell and dolomitic magnesia limestone grit laid as well as the groups which received oyster shell and hard (mica) grit, especially as there was insufficient dolomitic magnesia limestone grit consumed to cause any ill effect. Incidentally there was no significant evidence in these experiments to indicate that hard grit had any beneficial effect, either for feed disintegration or increased utilization of the feed.

Inasmuch as the negative results of the two years' experiments by the Ohio Agricultural Experiment Station are in agreement with the experimental results and interpretations of the New York, Utah, and Wisconsin Stations, it seems there is ample evidence to indicate that dolomitic (magnesia) limestone is ill suited for feeding poultry. Consequently, poultrymen and feed merchants should make every effort to secure oyster shell or calcium carbonate limestone grit of poultry-feeding grade.

An experiment now in progress at the Ohio Agricultural Experiment Station indicates how essential oyster shell or high calcium limestone grit is to egg production and how egg production and egg shell texture are affected

when the layers are denied their calcium. In this experiment the oyster shell previously available at all times was discontinued in one pen of 50 Rhode Island Red pullet layers; at the same time, in the adjoining pen the same number and kind of pullets continued to receive the ration with free access to oyster shell. The egg production of the two pens during the 10 weeks following the discontinuation of the oyster shell in the one pen is shown in table 2.

TABLE 2.—Egg production of Rhode Island Red pullets which received the same ration with and without oyster shell

September 30, to December 8, 1943—10 weeks

Weeks	Number of eggs laid each week by pullets which received			
	Oyster shell		No oyster shell	
	Unbroken eggs	Broken eggs*	Unbroken eggs	Broken eggs*
First	154	....	167	....
Second	140	....	146	1
Third	124	1	89	2
Fourth	110	....	40	4
Fifth	121	1	39	3
Sixth	139	....	87	6
Seventh	148	2	104	5
Eighth	155	2	121	4
Ninth	175	1	87	20
Tenth	172	....	97	8
Total	1438	7	977	53

*Eggs broken in nests because of weak or thin shells

A decline in the rate of egg production took place in both pens during the first 4 weeks of the experiment. However, the decline was much greater in the pen receiving no oyster shell, with the result that by the end of 10 weeks the pullets which continued to receive oyster shell had laid 47 per cent more eggs than those without. Besides the reduced number of eggs, the shells of the eggs that were laid by the pullets denied oyster shell became progressively thinner and weaker, as indicated by breakage of eggs in the trap nests. Moreover, when the eggs from both groups of pullets were subjected to a test of shell strength during the tenth week, 87 per cent of the eggs from the pullets that received oyster shell withstood breakage, whereas, only 36 per cent of the eggs from the pullets without oyster shell withstood breakage. This is not surprising in view of the fact that egg shells are about 94 per cent calcium carbonate and constitute about 30 per cent of the total dry matter of eggs. Moreover, under normal conditions oyster shell or high-calcium limestone grit constitutes 4 to 6 per cent of the total feed intake of layers.

At the end of the second week the pullets without oyster shell were scratching vigorously in the floor litter (wood shavings) in their effort to find something that might contain calcium. During the first 2 weeks these pullets consumed 4 pounds of granite grit. During the following 8 weeks they consumed an average of 17 pounds of granite grit each week in their effort to avoid calcium starvation. Needless to say these pullets, in self defense, con-

tracted the vice of egg eating. In contrast to the calcium starved pullets the other group which had free access to oyster shell and granite grit consumed an average of only 3 pounds of oyster shell and ½ pound of granite grit each week. From this it is obvious that oyster shell or high calcium limestone is a necessary constituent of the ration for layers.

While there are some available supplies of calcium carbonate limestone grit of poultry-feeding grade from other states, it is doubtful if there is any limestone grit now available from Ohio quarries which will meet the requirements for poultry feeding. No doubt there are some deposits of high-calcium limestone in Ohio or nearby states that can and will be made available for feeding poultry.

The common practice of adding 1 to 3 per cent pulverized limestone to poultry mashes as a source of calcium is questionable for two reasons: first, it may be fertilizer dolomitic magnesia limestone ill suited for poultry feeding; and second, it should be in a granular (chick-size grit) form for best results. The limestone grit or chick size oyster shell is more slowly dissolved and does not immediately neutralize hydrochloric acid (which has other important functions to perform) in the digestive tract as does finely ground limestone or oyster shell.

The primary advantage of oyster shell for poultry feeding is that it is a product standardized by nature and can be safely assumed to contain 95 to 98 per cent calcium carbonate. On the other hand, limestone is a highly variable product (even in the same quarry, in many instances) and requires a close checking of its calcium and magnesium contents when used for feeding poultry. Because limestone generally contains both calcium carbonate and magnesium carbonate, it is necessary, when testing limestone for poultry-feeding needs, to determine the actual percentage of calcium carbonate present instead of relying on the acid neutralizing power of the limestone as a measure of its value.

In view of the increased need and importance of 90 per cent or more calcium carbonate limestone for feeding poultry owing to the scarcity of oyster shell, and since the percentage of calcium is a simple, dependable index to the quality and safety of limestone for feeding poultry, it would seem that state feed and fertilizer control agencies might well include limestone for feeding poultry in their inspection services. Poultrymen need this safeguard against the unknowing use of dolomitic (magnesia) limestone for feeding their poultry. At the same time, feed merchants and manufacturers would be safeguarded against poultrymen's unknowing use of dolomitic limestone, the ill effects of which would, in many instances, be erroneously charged to mash mixtures or their ingredients which had been purchased.

SUMMARY

A suitable source of calcium in the form of calcium carbonate, such as oyster shell or 90 per cent or more calcium carbonate (poultry-feeding grade) limestone for egg shell formation, is as essential for egg production as other parts of the ration for layers.

Experimental evidence indicates that dolomitic (magnesia) limestone is ill suited for feeding poultry.

Chick-size oyster shell or chick-size calcium carbonate limestone grit of poultry-feeding grade should be used rather than the pulverized products when a calcium supplement is to be added to poultry mashes.

The primary advantage of oyster shell as a source of calcium for poultry feeding is that it is a product standardized by nature and can be safely assumed to contain 95 to 98 per cent calcium carbonate; whereas, limestone is a highly variable product (even in the same quarry, in many instances) and requires a close checking of its calcium content when used for poultry feeding.

Because there is a greater need for calcium carbonate limestone grit of poultry-feeding grade for feeding poultry and because the percentage of calcium is a simple, dependable index to its quality and safety for feeding poultry, it has been suggested that limestone, to be used for feeding poultry, should be included under the State Feed and Fertilizer Control Inspection Service. Then, limestone containing 90 per cent or more of calcium carbonate could be designated as such and could be bought and sold on the basis of its quality and safety for feeding poultry.

PEACH VARIETIES FOR OHIO

WESLEY P. JUDKINS

The descriptive material and evaluations of new and old peach varieties presented in this article are compiled from observations made in Ohio orchards and from reports published by workers in neighboring states. Varieties are listed in order of ripening, with approximate ripening date at Wooster indicated in each case. Ripening dates in southern Ohio are a week or two earlier than those being quoted here, while dates for northern Ohio would be a few days later.

The numerical values in the following table indicate the desirability of a variety as far as hardiness, fruit size, quality, firmness of flesh, and freeness of stone are concerned. The figure "5" represents maximum or top value, figure "3" is average, and "1" is very poor. For example, in the case of hardiness 5 indicates very hardy, 4 means hardy, 3 represents medium hardiness similar to Elberta, 2 means tender, and 1 means very tender. In the case of size, quality, and firmness, 5 indicates very large, very high quality, or very firm, 4 means large, high quality, or firm, 3 indicates average or medium, 2 means small, fair quality, or soft, and 1 indicates very small, poor quality, or very soft. In describing freeness of stone, 5 means freestone, 4 indicates a tendency to cling in some seasons, 3 means semi-clingstone, and 1 complete clingstone. The letter "Y" under flesh color indicates yellow flesh; whereas "W" represents white flesh.

The ratings are compiled chiefly from the point of view of the commercial orchard. The selections for the home orchard would be similar but personal preferences should have more influence in the final choice.

Varieties which ripen after Elberta are susceptible to serious injury by larvae of the Oriental Fruit Moth. For this reason late-maturing varieties are not recommended for commercial planting unless adequate parasites can be released to keep this pest under control.

TABLE 1.—Evaluation of peach varieties for Ohio
(Additional experience in different parts of the state may change the rating of the varieties here listed.)

Variety	Approximate ripening date	Color of flesh	Hardiness of buds	Fruit size	Fruit quality	Fruit firmness	Stone freeness	Remarks
Most important commercial varieties								
Cumberland	Aug. 14	W	4-5	3-4	3-4	3	4	Standard in its season.
Golden Jubilee	Aug. 15	Y	4	3-4	3	3	5	Too soft for shipping.
Halehaven	Aug. 27	Y	4	4	3	3-4	5	Fast becoming standard variety.
Belle of Georgia	Sept. 6	W	4-5	3-4	3	4	5	Preferred to Champion.
Elberta	Sept. 9	Y	3	4	2-3	4-5	5	Buds rather tender.
Varieties for limited commercial planting								
Erly-Red-Fre	Aug. 7	W	4	4	3	3	4	Attractive, promising.
Oriole	Aug. 11	Y	4-5	3	4	3	5	Best of its season.
Raritan Rose	Aug. 13	W	4	3-4	3	4	4	Firmer than Cumberland.
Pioneer	Aug. 14	W	5	4	3-4	3	4-5	May be soft.
Radiance	Aug. 17	W	4	4	4	3	5	Good to follow Cumberland.
Goldeneast	Aug. 23	Y	3-4	4	3-4	4	5	Good if hardier.
Vedette	Aug. 23	Y	4	3-4	4	3-4	4	Good canner.
Sunhigh	Aug. 25	Y	4	4	4	4	4	Promising.
Redrose	Aug. 28	W	4	3-4	4	4	5	Very promising.
Midway	Aug. 30	Y	4	3-4	4	3-4	5	Promising to follow Halehaven.
Champion	Sept. 3	W	4 5	4	4	3	4	Belle of Georgia preferred.
Kalhaven	Sept. 6	Y	3-4	3-4	3	4	5	Needs heavy thinning.
White Hale	Sept. 10	W	3-4	5	3	4	5	Best of its season.
Shippers Late Red	Sept. 11	Y	3-4	4	2-3	4	4-5	Some strains are poor.
Afterglow	Sept. 12	Y	4	4	3-4	4	5	Promising to follow Elberta.
Varieties to satisfy special local demands								
Mikado	Aug. 1	Y	4-5	3	2-3	2	3	Best of its season.
Marigold	Aug. 4	Y	4-5	3	2-3	2	3	Best of its season.
Fisher	Aug. 6	Y	3	3-4	4	3	4	Promising in some areas.
Redhaven	Aug. 9	Y	4	3	3-4	4	5	Firmer than Oriole.
Delicious	Aug. 17	W	4	4	3-4	3	5	Radiance preferred.
Early Halehaven	Aug. 20	Y	4	3-4	3	3-4	5	New.
Newday	Aug. 25	Y	3	4	3	4	4	Halehaven or Sunhigh preferred.
South Haven	Aug. 25	Y	4	3-4	3	3	4	Halehaven preferred.
Sun-Glo	Aug. 25	Y	4	3-4	3 4	3	4	Bud selected South Haven.
Colora	Aug. 25	Y	4	4	2-3	3	4	Halehaven or Sunhigh preferred.
Zarn!	Aug. 29	Y	3	4	2-3	4	5	Quality fair; buds tender.
Valiant	Aug. 29	Y	4	3-4	3-4	3-4	4	Halehaven or Midway preferred.
Veteran	Sept. 1	Y	4	3	4	3-4	4	Midway probably better.
Redelberta	Sept. 2	Y	3	3	3	3-4	5	Of questionable value.

TABLE 1.—Evaluation of peach varieties for Ohio—Continued

(Additional experience in different parts of the state may change the rating of the varieties here listed)

Variety	Approximate ripening date	Color of flesh	Hardiness of buds	Fruit size	Fruit quality	Fruit firmness	Stone freeness	Remarks
Varieties to satisfy special local demands—continued								
Eclipse	Sept. 2	Y	5	2-3	3	3	5	Small; needs heavy thinning.
Summercrest	Sept. 5	Y	4	4	4	3-4	5	Promising new variety.
Early Elberta	Sept. 6	Y	3	3-4	3	3-4	5	Kalhaven probably better.
Sungold	Sept. 7	Y	4	4	5	3-4	5	Promising.
J. H. Hale	Sept. 10	Y	3	5	4-5	3-4	5	Small tree; low yields.
Gage Elberta	Sept. 11	Y	3	4	2-3	4	5	Afterglow probably better.
Picketts Favorite	Sept. 11	Y	3	3-4	3	4	5	Afterglow probably better.
Kette	Sept. 13	Y	3-4	4	2-3	4	5	Good canner.
Hope Farm	Sept. 14	W	4	3-4	3	2-3	5	White Hale preferred.
Hardee	Sept. 14	Y	4	3-4	2-3	4	5	Tree only fair in vigor.
Brackett	Sept. 14	Y	3	3-4	3	4	5	Afterglow preferred.
Lizzie	Sept. 19	Y	4	3-4	3-4	4	5	Best of its season.
Iron Mountain	Sept. 20	W	4	3-4	3-4	3-4	5	Best of its season; unattractive.
Salberta	Sept. 25	Y	3	4	2-3	3-4	5	Best of its season.
Varieties of little commercial value								
Buttercup	Aug. 2	Y	4	2	2-3	2	3	Mikado or Marigold preferred.
Arp Beauty	Aug. 4	Y	1	3	2-3	2	4	Mikado or Marigold preferred.
Greensboro	Aug. 6	W	5	2-3	2	2	3	Erly-Red-Fre preferred.
Sunbeam	Aug. 11	Y		3-4	2	3-4	3	Good freezer; does not discolor.
Carman	Aug. 17	W	5	3	2	1	3	Soft; fair quality.
Triogem	Aug. 17	Y	2	4	4	4	5	Good but buds tender.
Rochester	Aug. 19	Y	4-5	3	3-4	3-4	4	Susceptible to arsenical injury.
Fireglow	Aug. 23	Y	2	4	4	4	5	Good but buds tender.
Golden Globe	Aug. 25	Y	2	4	3-4	3-4	5	Buds tender.
July Elberta	Aug. 26	Y	3	3	2-3	4	5	Halehaven preferred.
Pacemaker	Aug. 30	Y	3	5	4	4	5	Tree lacks vigor.
Polly	Sept. 6	W	3	4	3	3	5	Good canner.
Primrose	Sept. 6	Y	3	2-3	3	3-4	5	Kalhaven or Summercrest preferred.
Halberta Giant	Sept. 10	Y	3	5	4	3-4	5	Resembles J. H. Hale.
Candoka	Sept. 10	Y	1	4-5	3-4	4	5	Buds very tender.
Welcome	Sept. 11	Y	3-4	4	3	3-4	5	Afterglow probably better.
Fertile Hale	Sept. 11	Y	3-4	4	2	3	5	Poor quality; soft.
Halberta	Sept. 12	Y	3	3-4	4	3	5	Afterglow hardier.
Rio-Oso-Gem	Sept. 15	Y	3	4	3	4	5	Tree small; buds tender.
Wilma	Sept. 15	Y	2	4	3	4	5	Buds tender.
Williams Cling	Sept. 23	Y	3-4	3-4	2-3	3-4	1	Good for pickling.
Lemon Free	Sept. 25	Y	4	3	2-3	3	5	Fair quality; good canner.
Salway	Oct. 17	Y	3	3	2	3-4	5	Fair quality; tender buds.
Krummel October	Oct. 24	Y	3	3	2	3-4	5	Too late, may not ripen.

PEACH PLANTING IN WARTIME

WESLEY P. JUDKINS

It is to be expected that the high prices which were received for peaches during the past two seasons may stimulate the planting of trees during the spring of 1944. In making plans for this activity during these unsettled war years, let us first consider the small back yard planting and then the orchard of commercial size.

SMALL BACKYARD PLANTING

It is usually much easier for the home gardener to produce good crops of vegetables and berries than of tree fruits, such as apples, peaches, plums, and cherries. The diseases and insects which attack fruit trees are difficult to control in the back yard orchard because of inadequate spray equipment, and they often destroy the crop or make it unfit for human consumption. Vegetables, on the other hand, may be sprayed or dusted with small hand equipment and the pests kept within reasonable bounds. Raspberries and strawberries require little or no spraying for the control of insects or diseases.

If, in spite of the above precautions, the home gardener wishes to set out a few fruit trees, it is necessary that soil selection and management, pollination, and insect and disease control be thoroughly understood and measures be adopted to properly handle these problems.

COMMERCIAL PEACH PLANTING

In commercial peach orchards a reasonable number of trees must be planted each year if the present peach industry is to be maintained. However, each individual farm enterprise must be studied carefully to determine if the acreage in fruit trees should be expanded in consideration of possible post-war market condition.

The important problem at the moment is to produce the maximum amount of food for the duration. Peach trees require about 4 years to reach profitable production. Since it is impossible to determine when the war will end and since it is to be expected that prices will undoubtedly be lower after the war is over, the conservative farmer will avoid over-expansion. The disaster which may follow such over-expansion is well illustrated by the fact that during World War I many farmers purchased land at high prices, with the result that farm debts rose 43 per cent. During the depression which followed the war, many good farmers lost their entire investment because of the heavy debt load they were carrying.

Congress has attempted to insure a continuance of fair prices to farmers for a period of 2 years after the war is over. There is no doubt but what the devastated countries of Europe will need large quantities of food as soon as hostilities cease. A recent report of a united nations' conference on food and agriculture has indicated that international trade in food and textile products should be both large and expanding for a long time. A collapse in demand and prices of farm products such as occurred shortly after the last war is not expected.

It is also true that after a few years of transition, major wars are usually followed by several years of rapid industrial expansion and a high level of urban prosperity, as was the case during the 1920's. Relatively high prices may be paid for choice foods. Fruit growers in favorable locations may take advantage of such a situation, but farm operations must be planned and adjusted to high farm wages.

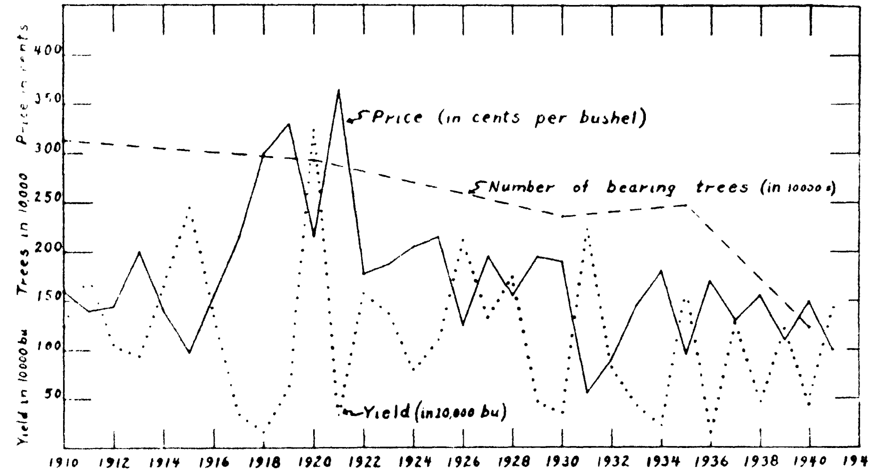

Fig. 1.—Number of peach trees, yield, and price per bushel in Ohio—1910 to 1940

As has already been indicated, 8 to 10 per cent of the present commercial acreage of peach trees should be replanted each year if the industry is to be maintained. Figure 1 illustrates this point and shows that the number of bearing trees in Ohio has decreased steadily since 1910. Yearly production has dropped from an average of nearly 1,500,000 bushels to less than 1,000,000 bushels. Since Ohio is located in one of the most highly populated regions in the United States, it is reasonable to expect that there should be adequate markets for good peaches. There have been, however, large plantings in certain southern states during recent years which will affect to some extent the markets farther north.

Figure 1 also shows that peach production is a very hazardous type of agriculture. Variations in yearly production of from approximately 200,000 to over 2,000,000 bushels are not unusual. According to the U. S. Department of Agriculture the average annual production of peaches in Ohio from 1930 to 1939 was only 44 per cent of a full crop. This is a serious matter, since full production is considered as less than one bushel per tree. Indiana, Illinois, and Missouri have similar production hazards; whereas New York, Pennsylvania, New Jersey, Georgia, and the Carolinas average about 60 per cent of a full crop. The climatic conditions in California are sufficiently favorable to give nearly 80 per cent full production each year. It is reasonable to conclude that peach trees should not be planted in Ohio by people who do not have the equipment or experience to manage an orchard properly.

With these facts in mind, it would seem to be a good policy for the farmer to take advantage of the present period of relative prosperity and pay his debts. Production of food should be increased as far as possible by the intensive use of present facilities. Then, if a moderate planting of peach trees seems to be justified, the following points concerned with planting and management should be considered.

SOIL

The soil in which peach trees are planted has a very important influence on their growth and productivity, and, consequently, on the profit the grower may hope to gain from the orchard. For best growth, peach trees should be planted in well-drained, fertile soil, which preferably has a depth of 2 feet before reaching impervious clay or rock. Well-drained soils have a uniform brown color. Poorly drained soils are characterized by a pronounced gray layer, or by a gray and mottled subsoil, and are not suited for peach production.

SITE

In addition to having a good soil, the site upon which peaches are planted should have good air drainage to help reduce injury by spring frosts. Adequate air drainage may be obtained by selecting a site which is elevated above the surrounding country or else protected by large bodies of water or strong air currents.

Low areas and valleys where frosts occur late in the spring should be avoided. Certain portions of orchards frequently are unprofitable for these reasons.

VARIETY

After a suitable soil and site have been selected, the question of what variety of peach to plant must be considered. Because of the recent introduction of a number of good, high quality peaches which ripen in August and because of the injury to late-ripening peaches by the larvae of the Oriental fruit moth, the present trend is toward the use of varieties which ripen in August or early September and the discarding of varieties which ripen after Elberta.

The grower should select varieties which are in demand in his particular section. Consideration should be given to the ripening date, hardiness, color of flesh, suitability for shipping, dessert and canning qualities, size, freeness of stone, and general attractiveness. More detailed information on varieties may be obtained from your County Agricultural Agent or from the Agricultural Experiment Station.

TIME OF PLANTING

The best time to plant peach trees in Ohio is during very early spring. Fall planting in late October or early November may be successful in southern Ohio, but in years having very cold winters many of the young trees may be killed.

Trees to be planted in the spring of 1944 should be ordered during the winter. A request should accompany the order indicating that the trees be delivered during early April. There are many reliable nurseries in Ohio and neighboring states which sell well grown, thrifty trees. Large, one-year-old trees are best for either commercial or home orchard planting. Trees which are 2 years old may be satisfactory, but they are more expensive and frequently do not recover from the shock of transplanting as quickly as younger trees. The largest one-year-old trees are best, and nothing smaller than the medium-sized plants should be considered.

During the spring of 1943 all types of fruit trees were rather scarce. In case the same situation develops during the next spring it would seem to be advisable to get orders into the hands of nurserymen just as early as possible.

SOIL PREPARATION AT PLANTING TIME

The field or orchard where the young trees are to be planted should be plowed and disked as early in the spring as the soil can be worked. Only a moderately good job of disking or harrowing is necessary. A fine seedbed is not needed for orchard planting and is more susceptible to erosion than soil left in a coarser, more trashy condition.

HANDLING TREES BEFORE PLANTING

If the soil is in proper condition for planting when the trees arrive at the farm, they should be set out at once. If such a procedure is impractical for any reason, the trees should be heeled in by burying the roots in soil with the tops slanting to the south to prevent sun injury to the trunks and branches. The trees may be kept for short periods in a cold storage room if such facilities are available. The important point is to keep the roots moist at all times regardless of the method used in handling the trees.

LAYING OUT THE ORCHARD

On sites which are not too hilly most peach orchards are planted in a square system with trees 20 to 24 feet apart. On hilly land a contour system may be preferred in order that erosion may be more easily controlled. The trees should be arranged in straight rows or systematic contour lines to facilitate cultural, spraying, and other operations which must be performed in the orchard.

SETTING PEACH TREES

The actual planting of the trees is a comparatively simple matter, but it must be carefully done if good growth is to be expected. The hole for the roots of the young tree must be of sufficient size that all roots may be extended to their full length without touching the sides of the hole. Root pruning, except for the removal of broken, dead, or diseased roots, is not recommended and may be actually injurious.

The young tree should be set about 2 inches deeper than when it was growing in the nursery. Fertile topsoil should be worked in around the roots and packed down firmly by treading on the loose soil as it is shoveled in around the tree. If the soil is dry, a half-bucket of water poured into the hole when it is about one-third full of soil, will help give the tree a better chance to grow.

FERTILIZING YOUNG TREES

No fertilizer is needed for fruit trees during the first year after they are set out. The placing of fertilizer or fresh manure in the hole in which the tree is planted may be actually injurious and kill the young plant.

PRUNING YOUNG TREES

At the time peach trees are planted their main trunk should be headed back to a height of from 24 to 40 inches, depending on the system of pruning which is to be followed later on. All lateral branches should be pruned back to short spurs of one bud each. This may seem like drastic treatment, but it results in good growth and strong trees if future de-shooting and pruning are properly performed.

CULTURE OF YOUNG ORCHARD

Finally, the young peach orchard should be rough or trash cultivated during the late spring and early summer. In early July a crop of soybeans is commonly planted, although weeds may be allowed to grow to act as a summer cover crop. The soybeans should be disked down in early September and a winter cover crop of rye seeded by the middle or latter part of September.

DELAWARE VERSUS CATAWBA GRAPES IN OHIO

WILLIAM K. STEUK

The Delaware variety of grape is accorded the honor of being the best native grape for white wines. In addition, the vine characters are such that it will endure severe climatic conditions fatal to all but the most hardy varieties. The fruit ripens early, a fact which insures the harvest of each crop.

Yet, in spite of the honors granted this excellent grape, it does not hold an important place in the wine-grape industry of Ohio. The annual Delaware crop will not exceed 100 tons in a favorable year; whereas the Catawba crop will approximate 800 tons annually. The Niagara, although not strictly a wine grape, is frequently used for this purpose. It is usually produced in the amount of 700 tons.

The Delaware grows successfully in all of the grape-producing counties of Ohio. On the other hand, culture of the Catawba is restricted to special localities in Erie and Ottawa Counties. In the Lake Erie Islands many growers will not plant the Delaware, devoting their attention almost exclusively to the Catawba.

Tests comparing the Delaware and Catawba grapes are now in progress at the Steuk Vineyards near Sandusky in Erie County. Data were first collected this season (1943) on young and old Catawba and Delaware plantings but further data will be gathered for a period of years. Although the "old" Catawbas and Delawares are not directly comparable because of great differences in age, they contrast strikingly with the 3-year old vines. The vines are all planted 8 feet by 6 feet, or at the rate of 907 vines per acre. The data are presented in table 1.

TABLE 1.—Yield records and associated data from young and old Delaware and Catawba grape vines, 1943

	Young Delaware 3 years old, 9/15/43	Old Delaware over 90 years, 9/15/43	Young Catawba 3 years old, 10/13/43	Old Catawba about 35 years old, 10/13/43
Number of vines	100	99	91	67
Total weight of grapes, (pounds)	6.5	511.9	106.0	616.4
Average weight of grapes per vine, (pounds)	.065	5.170	1.164	9.200
Yield per acre, (pounds) (calculated)	59	4,689	1,056	8,344
Yield per acre, (tons) (calculated)	.029	2.34	.52	4.17
Selling price per ton, (dollars)	$200.00	$200.00	$180.00	$180.00
Value of grapes per acre, (dollars)	$ 5.90	$468.90	$ 95.04	$750.96
Value in excess of young Delaware per acre, (dollars)	...	...	$ 89.14	...
Value in excess of old Delaware per acre, (dollars)	...	...	...	$282.06

When these data are analyzed the relatively unimportant position of the Delaware as a wine grape is easily understood.

The yield per acre of the old Delaware planting was approximately one-half that of the old Catawba. This difference has been recorded by other investigators on vines nearer the same age. The difference is caused by the smaller clusters and berries of the Delaware, as both varieties are usually pruned to an equal number of buds.

With the exception of the Delaware, our commercial varieties produce a substantial crop during the third growing season.

The young 3-year-old Catawba planting produced almost 18 times as much fruit as the Delaware vines of equal age. These 3-year-old Delaware vines do not at present indicate much promise of producing a profitable crop until their fifth growing season. Growers are naturally reluctant to plant grapes which are so tardy in reaching a profitable bearing age.

Fig. 1.—The row of grapes to the left, are 3-year-old Catawba vines and those on the right, 3-year-old Delaware vines. These Catawbas produced, in 1943, at the rate of ½ ton to the acre and the Delawares only 59 pounds to the acre.

Delawares have sold at more per ton than Catawbas in recent years, but this additional sum has never been sufficiently high to compensate for lower yields. Although the prices prevailing in the past season were not normal but resulted from war restrictions on the wine and grape industry in the United States, the acre yield of Catawba grapes, identical with those in the experiment, was worth $282.06 more than an acre of the Delaware variety. This year's data would indicate Delawares should be worth twice as much as Catawbas to return a similar amount per acre, but an exact ratio cannot be accurately stated until the experiment has been conducted a few more years.

The majority of Ohio wineries, bent on producing a wine that can be profitably marketed at a low price, have long discriminated against the more expensive Delaware grape. The growth of a greater appreciation of high quality wines and champagnes may result in the higher prices the Delaware variety needs to compete successfully with other grapes on a profit basis.

It is reasonable to conclude from these data and from past experiences, that wherever Catawba grapes can be successfully matured they should be more profitable than the Delaware variety and thus should be given preference in future plantings. However, if the production of fine wines and champagne is to be expanded in Ohio, the Delaware may command a sufficient premium to justify planting it. The Ohio wine industry has entered markets formerly dominated by foreign wines and champagne, and, to hold this position in the future, quality standards must be raised and maintained.

THE USE OF ALKYLATION PHOSPHATE WITH RESPECT TO TOXICITY[1]

I. W. WANDER

One of the methods for making high test gasoline for aviation purposes involves the use of large quantities of sulfuric acid. This process, known as the Alkylation process, leaves the acid about as strong as it was originally with respect to acid properties but containing some aromatic compounds which make the acid unfit for further use in the process. Rock phosphate, when treated with this alkylation acid, forms a product similar to superphosphate, except for these aromatic compounds. The product is dark in color, is highly odoriferous, and has a texture similar to 20 per cent superphosphate.

At the request of Dr. A. R. Olpin, Director of Industrial Research, and Dr. W. C. Fernelius, formerly Professor of Chemistry of the Ohio State University, some comparative tests were set up in the greenhouses at the Ohio Agricultural Experiment Station at Wooster to determine whether there would be any injurious effect from the use of this alkylation phosphate as compared with the usual commercial form of 20 per cent superphosphate.

Three different experiments using pots, a ground bed, and flats—all in the greenhouse—were set up, and different rates and methods of application of this alkylation phosphate used on 12 different kinds of plants. The procedure is given below.

EXPERIMENT NO. 1

Fifteen 6-inch pots divided into three different rates of treatment were used. Five pots contained soil mixed with alkylation phosphate at the equivalent of 1,000 pounds per acre; five at the rate of 2,000 pounds per acre, and five at 4,000 pounds per acre, the latter being extremely high. Soybeans, peanuts, cotton, corn, and tomatoes were grown under these three treatments from March 25, 1942 until June 1, 1942. Pictures were taken on May 6, 1942, of the plants receiving the low and high treatments—1,000 and 4,000 pounds per acre, respectively, (figure 1). The result of the low treatment is pictured on the left and the high on the right. No toxic effects were noted on any of the plants. However, the corn and cotton were somewhat smaller under the high treatment than under the lower one; whereas the tomatoes and soybeans seemed to benefit from the higher treatment as compared with the lower one. Peanuts showed no effect from the treatment. Tomatoes under the higher treatment reached full bloom about 3 days earlier than those under the lower treatment. However, tissue tests showed this might have been due to slight differences in available nitrates. By June 1, the differences noted above did not exist, except in the case of corn which was still somewhat retarded under the high treatment.

[1]Experiments conducted under the supervision of Professor J. H. Gourley, Chief of the Department of Horticulture, at the Ohio Agricultural Experiment Station, as a part of a cooperative project between The Southern Acid and Sulphur Company and The Ohio State University Research Foundation.

EXPERIMENT NO. 2

A ground bed in the greenhouse 54 feet long and 7 feet wide was divided into four equal plots 12¾ feet long with 1-foot buffer strips between plots. Each plot equaled 91 square feet, or 0.00209 acre.

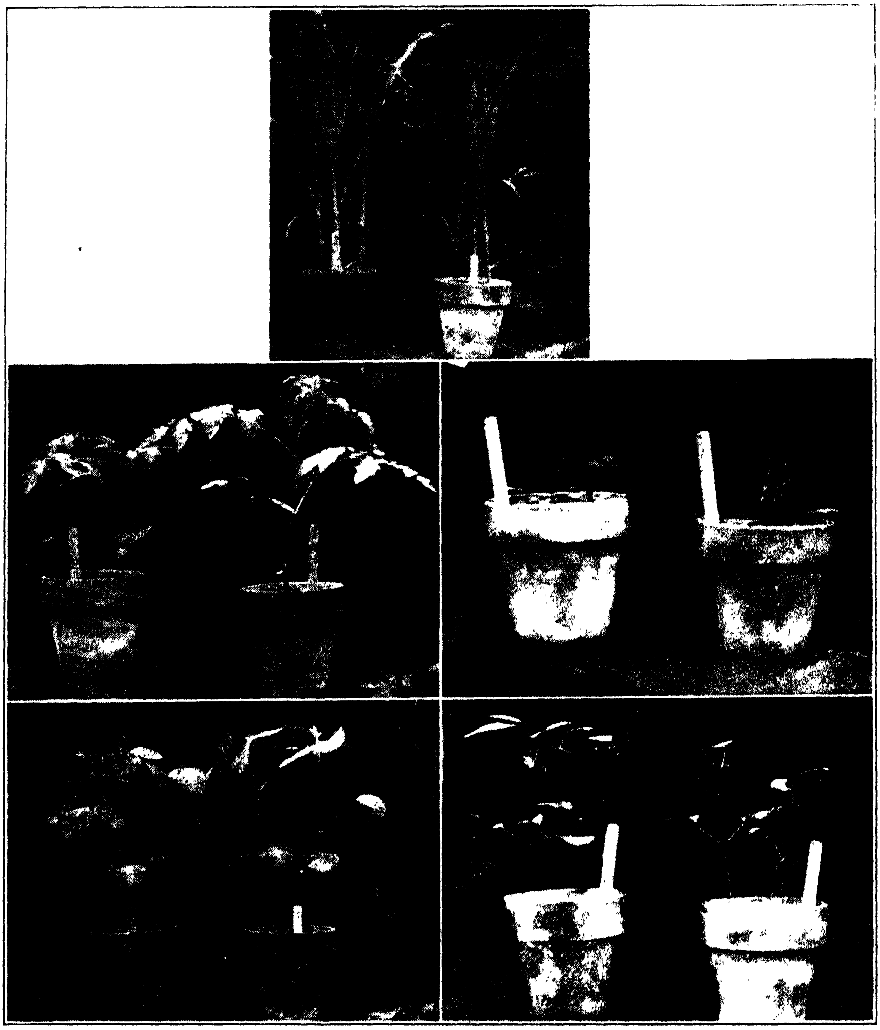

Fig. 1.—Application of 1,000 and 4,000 pounds per acre of alkylation phosphate on (1) corn, (2) tomatoes, (3) soybeans, (4) peanuts, and (5) cotton, growing in 6-inch pots. In each case the 1,000 pounds per acre treatment is on the left and the 4,000 pounds per acre treatment is on the right. No toxicity due to the use of these amounts of alkylation phosphate was apparent during a period of 6 weeks.

Plot No. 1 received 300 pounds per acre of alkylation phosphate on April 6, 1942, broadcast and raked in just before planting and additional alkylation phosphate was broadcast on May 5, 1942 to give a total of 2,000 pounds per acre.

Plot No. 2 received 300 pounds per acre of regular 20 per cent superphosphate, broadcast and raked in on April 6, and additional 20 per cent superphosphate on May 5 to total 2,000 pounds per acre.

Plot No. 3 received 600 pounds per acre of alkylation phosphate, broadcast and raked in on April 6, and additional alkylation phosphate broadcast on May 5 to total 4,000 pounds per acre.

Plot No. 4 received alkylation phosphate on May 5, 1942 in row or hill application, depending on the plant, equivalent to 2,000 pounds per acre.

Fig. 2.—Lettuce, radish, swiss chard, cucumber, and buckwheat growing in flats of soil to which had been added 2,000, 4,000, and 6,000 pounds per acre of alkylation phosphate. No injurious effects were noted from any of the above rates of application.

All plots were planted April 6 with ageratum, cabbage, soybeans, cotton, peanuts, tomatoes, and corn. The ageratum, cabbage, and tomatoes were transplants.

No differences due to the use of alkylation phosphate as compared with regular 20 per cent superphosphate were noted on any of the plants grown under the treatments as outlined above. Corn, which was less vigorous under the high treatment of experiment 1, did not seem to be so affected when ample space was provided for root growth.

EXPERIMENT NO. 3

Four flats, containing 30 pounds of potting soil each, were prepared and planted on May 6, 1942, with lettuce, swiss chard, radish, cucumber, and buckwheat. The treatments used were as follows:

Flat No. 1—no treatment
Flat No. 2—alkylation phosphate = 2,000 pounds per acre
Flat No. 3—alkylation phosphate = 4,000 pounds per acre
Flat No. 4—alkylation phosphate = 6,000 pounds per acre

TABLE 1.—The effect of equivalent amounts of alkylation phosphate and superphosphate on the soil reaction and available phosphorus content of greenhouse and potting soil

Sample	Sample date	Treatment	pH	Available phosphorus in P. P. M.
No. 1—Soil 0-8-inch depth from south end of bed in the greenhouse.	3-9-42	Before treatment.	6.38	100
No. 2—Soil 0 8-inch depth from middle of bed in greenhouse.	3-9-42	Before treatment.	6.38	75
No. 3—Soil 0-8-inch depth from north end of bed in greenhouse.	3-9-42	Before treatment.	6.38	75
No. 4—Soil 0-8-inch depth from plot No. 1 south end of bed in greenhouse.	6-27-42	Alkylation phosphate equivalent to 2,000 pounds per acre of 20 per cent superphosphate broadcast and raked in.	6.70	>300*
No. 5—Soil 0 8 inch depth from plot No. 2.	6-27-42	2,000 pounds per acre, 20 per cent superphosphate broadcast and raked in.	6.65	>300*
No. 6—Soil 0-8-inch depth from plot No. 3.	6-27-42	Alkylation phosphate equivalent to 4,000 pounds per acre of 20 per cent superphosphate broadcast and raked.	6.42	>300*
No. 7—Soil 0-8 inch depth from plot No. 4, north end of bed in greenhouse.	6-27-42	Plot 4 consisted of row application of alkylation phosphate. The sample was taken from between the rows to give the changes occurring during a period of 110 days.	7.28	200
No. 8—Potting soil used in flats.	5-6 42	Before treatment.	6.50	150
No. 9—Soil from flat No. 1.	6-27-42	Check—no treatment.	7.40	200
No. 10—Soil from flat No. 2.	6-27-42	Alkylation phosphate equivalent to 2,000 pounds per acre of 20 per cent superphosphate.	7.15	>300*
No 11—Soil from flat No. 3.	6-27-42	Alkylation phosphate equivalent to 4,000 pounds per acre of 20 per cent superphosphate.	7.04	>300*
No. 12—Soil from flat No. 4.	6-27-42	Alkylation phosphate equivalent to 6,000 pounds per acre of 20 per cent superphosphate.	6.78	>300*

pH of the materials used:

First batch of alkylation phosphate	2.05
Second batch of alkylation phosphate	2.37
Twenty per cent superphosphate	3.12

pH determinations were made with a glass electrode, using a soil water ratio of 1:2.

*Greater than the limit of the test used which was 300 parts per million of available phosphorus.

No toxic effects from the use of the alkylation phosphate were noted on any of the plants used in this test. In fact, some of the plants, especially the buckwheat, were more vigorous where the phosphate was used. However, only an experiment involving yield data would answer the question of its value as a fertilizer.

A picture of these flats was taken May 28, 1942 (figure 2).

pH and available phosphorus determinations were made on soil samples taken from these experiments after periods of from 1½ to 3 months.

CONCLUSIONS

Corn, tomatoes, peanuts, cotton, soybeans, buckwheat, cabbage, cucumbers, lettuce, radish, swiss chard, and ageratum plants grown with alkylation phosphate as the source of phosphorus fertilizer showed no toxic effects from rates of application equal to or above the rate of 20 per cent superphosphate application that might be used in the greenhouse.

Since the rates of application were considerably above what would ordinarily be used in the field for such crops no toxic effects should be experienced from its use in the field.

No great change in soil reaction resulted from the use of alkylation phosphate in amounts comparable to 20 per cent superphosphate.

Both the alkylation phosphate and 20 per cent superphosphate in the amounts used increased the available phosphorus content of the soil.

THE EFFECT OF CERTAIN ENVIRONMENTAL FACTORS ON THE GROWTH OF CATTLEYA ORCHIDS

JEANNE MONTGOMERY AND ALEX LAURIE

Orchid culture in the Northern Hemisphere, although quite successful, has many phases as yet not fully understood. A complete understanding of the effect of such controllable factors as heat, light, temperature, humidity, and nutrition means better control over flower production and perhaps over time of flower production. Some of these things are already known by the best orchid growers, but others are not clearly understood.

Work in orchid culture was started at The Ohio State University in 1939. At that time work on nutrition was started, using gravel culture as a method of study. The results of this work have been reported previously in the Orchid Review (1). These results led to further work on orchid nutrition and on gravel culture as a method of growing orchids commercially, as well as experimentally.

Studies were also started to determine the effect on both vegetative and reproductive growth of several other environmental factors. These experiments included studies on use of fertilizer, acidity of water, and use of artificial light to increase light intensity and to change the length of day. The work was carried out under greenhouse conditions, and the factors were controlled by practical methods which could be used in actual practice.

GRAVEL CULTURE

After successfully growing Cattleya seedlings in pots of gravel, the work was expanded to include plots of several mature plants. In July 1941, several plots were started using two mediums, B-grade haydite (2) with ¼- to ½-inch mesh and FF-grade haydite with a ⅛- to ¼-inch mesh. Two solutions were used, ½ WP and Special ½ WP, which was a modification of ½ WP, using chloride salts as a source of the essential ions, instead of the sulfate salts.

The composition of these solutions is given in table 1 and table 2.

TABLE 1.—The composition of the Ohio WP solution

(Used one-half strength in experiments)

Chemical	Grams per gallon	Millimolar concentration
Potassium nitrate (KNO_3)	2.63	6.9
Ammonium sulfate ($(NH_4)_2 SO_4$)	0.44	0.9
Magnesium sulfate ($MgSO_4.7H_2O$)	2.04	2.2
Monocalcium phosphate ($CaH_4(PO_4)_2$)	1.09	1.4
Calcium sulfate ($CaSO_4.2H_2O$)	4.86	7.5
Additions:	**Additions per gallon**	
Iron sulfate ($FeSO_4.7H_2O$)	0.5 grams	
Manganese sulfate ($MnSO_4$) 1% solution	5 cc	

(1) American Orchid Society Bulletins, 9: No. 7 and 10: No. 7.
(2) A product of the Hydraulic Press Brick Co., South Park, Ohio.

TABLE 2.—Composition of the special WP solution
(Used one-half strength in experiments)

Chemical	Grams per gallon
Sodium nitrate ($NaNO_3$)	1.06
Potassium chloride (KCl)	1.12
Calcium chloride ($CaCl_2$)	1.32
Magnesium chloride ($MgCl_2$)	0.38
Ammonium chloride (NH_4Cl)	0.16
Monocalcium phosphate ($CaH_4(PO_4)_2$)	0.48
Additions:	Additions per gallon
Iron sulfate ($FeSO_4 \cdot 7H_2O$)	0.5 gram
Manganese ($MnSO_4$) 1% solution	5 cc

The plots were pumped by subirrigating with the solutions from outlets in the bottom of the plots, attached to a storage tank. Solutions were pumped whenever the medium was sufficiently dry. In summer, pumping was necessary several times a week but, in the winter, the plots went from 10 days to 2 weeks without pumping.

Cattleya pinole, a five-generation hybrid was used in this experiment. The plants were from 5 to 6 years old and were in excellent vigor. They were planted twelve to a plot, 27 inches by 32 inches, directly from 3-inch pots without removing any of the osmunda. Check plants were grown in pots of osmunda fiber, having been repotted from 3-inch to 4-inch pots.

TABLE 3.—Average gain in leaf area per plant measured in square centimeters

Medium	Solution	Average gain up to July 1942	Average gain up to June 1943	Total average gain July 1942–June 1943
B-grade	½ WP	87.8	58.5	146.3
Haydite	Special ½ WP	97.8	26.9	124.7
FF-grade	½ WP	119.2	94.2	213.4
Haydite	Special ½ WP	126.4	30.9	147.9
Osmunda	Water	117.6	80.2	206.3

TABLE 4.—Average flower production per plant of *C. pinole*

Medium	Solution	Flower production to July 1942	Flower production July 1942 to June 1943
B-grade Haydite	½ WP	1.50	3.83
	Special ½ WP	1.75	2.50
FF-grade Haydite	½ WP	1.75	2.75
	Special ½ WP	2.33	2.70
Osmunda	Water	1.08	1.60

At the end of a year, records were taken on gain in leaf area and on flower production. Again, at the end of 2 years, records were taken. Table 3 shows the average gain per plant in square centimeters of leaf area. Table 4 shows the flower production at the end of June 1942 and June 1943.

As shown in table 3 by the July 1942 records, the finer grade haydite seemed more conducive to leaf growth than the coarser grade, regardless of solution. The plants grew better the first year in the Special solution but at the end of the second year the plants were better in ½ WP solution. The totals for the two periods indicate that the finer grade medium was superior. The plants grown in osmunda gained in leaf area equal to those in gravel.

Table 4 shows the flower production for the same periods and indicates a distinct advantage in production of gravel-grown plants over those grown in osmunda. The plants were equal in vigor as shown by the figures in table 3. Again, in the first year the plants in the finer medium and Special ½ WP produced more flowers, but by the end of the second year the plants receiving ½ WP solution were more productive. The explanation for this change is not quite clear. Some investigators believe that chloride ions cause harder growth and, therefore, higher and better reproductive growth. This seems to be the case the first year but evidently did not hold the second year. In both periods, the check plants were far inferior in number of flowers produced.

Fig. 1.—*Cattleya pinole* plants in sheath in July 1942

Figure 1 shows the plots with the plants in sheath in July 1942, and figure 2 shows the same plants in flower in February 1943.

This experiment indicates that Cattleyas will grow and will flower better when grown in gravel culture than when grown in osmunda. Experience has shown that this method is not a cure-all for unhealthy plants but will be successful only when vigorous and healthy plants are used. Care must be taken not to disturb the roots after the plants are established. The gravel can be over-watered but this is less likely than in osmunda. Planting directly from pot to gravel, when the osmunda ball is small, proved most satisfactory. To be successful on a large scale, plants should be of the same

size, age, and vigor and a hybrid which will flower at about the same time. If the hybrid is one that requires a definite rest period, the solution must be withheld from the whole plot, not from just one plant.

The greatly reduced labor and the increased flower production should be considered as some advantages of this type of culture. Whether tried by an amateur or a professional, it should be tried on a small scale. It will take a great deal of work to bring the methods of growing orchids in gravel to the same level as the present success of gravel culture with roses.

Fig. 2.—*Cattleya pinole* plants in flower in February 1942, after 19 months in gravel culture

ADDITION OF FERTILIZERS

Since the use of a nutrient solution in gravel culture was the outstanding difference between the gravel-culture method and the osmunda method, the same gain in flower production might be shown when a nutrient solution was applied to Cattleya grown in pots of osmunda.

The addition of ½ WP solution was tested in conjunction with an experiment on various day-lengths, to be discussed later. Three hybrids were used, *C. pinole, C. chico, and C. higos.* These plants, 216 in all, were alloted to 3 day-length periods, then in each day-length period there were two groups of plants, those to be watered with ½ WP solution and the check plants to receive water only. Equal numbers of each hybrid were in each plot.

Additions were made each time the plants needed watering and no attempt was made at any time to leach the solution out of the osmunda. The solution was applied by hose from a storage tank.

Table 5 shows the gain in leaf area for the first year, table 6 shows the flower production over the first year, and table 7 gives it for the second year.

TABLE 5.—Average increase in leaf area measured in square centimeters of plants under three day-length conditions for the first year

Test	Solution	*C. pinole*	*C. higos*	*C. chico*	Totals—Average
Normal day	½ WP	85.5	53.2	34.2	57.6
	Water	56.7	104.4	68.7	76.6
Long day	½ WP	41.8	32.0	32.5	35.4
	Water	26.8	52.7	24.9	34.5
Short day	½ WP	61.5	95.5	69.6	75.5
	Water	118.6	50.2	99.0	89.3

TABLE 6.—Average flower production of plants under three day-length conditions during first year

Test	Solution	*C. pinole*	*C. higos*	*C. chico*	Totals—Average
Normal day	½ WP	2.75	.50	.91	1.38
	Water	1.08	.08	.66	.61
Long day	½ WP	.75	.41	.33	.50
	Water	1.00	.16	.41	.52
Short day	½ WP	2.08	.16	.33	.86
	Water	1.83	0	.33	.72

TABLE 7.—Average flower production for solution test the second year

Test	*C. higos*	*C. chico*	Totals—Average
½ WP	1.39	.72	1.05
Water	.56	.81	.68

The advantage, in leaf area gained, of plants receiving the solution over the plants not receiving the solution was not consistent. For the normal day where no outside factor was involved, the gain where water alone was applied was greater in all varieties. Here, the plants receiving solution gained an average of 57.6 square centimeters, while those with water applied gained an average of 76.6 square centimeters. An average leaf 20 centimeters long and 5 centimeters wide contains approximately 66.1 square centimeters of leaf area.

In July 1942, the day-length test was discontinued and only the fertilizer test was continued with just two of the hybrids, *C. chico* and *C. higos*. *C. pinole* was removed for other experiments. Table 6 shows the production on the original test up to July 1942 and of the two remaining hybrids up to June 1943.

The results for the first year show a decided advantage of using solution over water alone, in the hybrid *C. pinole.* The other two hybrids did not show this difference as well until the second year when the production of *C. higos* with the addition of fertilizer was high.

This test gives the same indications of the benefit of a fertilizer solution as was indicated in the gravel-culture test. Fertilizing could more advantageously be applied during certain periods, probably in connection with flower-bud initiation (3), since there was little difference in the size of plants or of flowers produced. Also debatable is the practice of applying fertilizer at every watering when fewer applications might do as well or better.

ACIDITY STUDIES

In this test, two hybrids were used, *Lc. mygdon* and *C. shackamaxon.* They were divided into three plots, each containing ten plants of each hybrid. One plot was watered with water maintained at pH 4.0, one plot at pH 6.0, and one at pH 8.0.

TABLE 8.—The average increase per plant in leaf area measured in square centimeters

	Lc. mygdon	*C. shackamaxon*	Average totals
pH 4.0	36.8	30.4	33.6
pH 6.0	37.7	31.6	34.6
pH 8.0	29.9	18.0	24.0

Table 8 gives the results in average gain in leaf area per plant during the first year and table 9 gives the average flower production per plant for the first and second years. Both leaf growth and flower production were better in the plot where the water used was maintained at pH 6.0. This is in accordance with the best cultural practices, but such a wide range in pH shows a wide degree of tolerance of Cattleyas. There was no visible difference in the plants in the three plots.

(3) Johnson, C. R. 1943. A study of flower initiation and development in the orchid *Cattleya pinole*. Amer. Orchid Soc. Bull. 11: 422-425.

TABLE 9.—The average flower production per plant over two years

	July 1941 to July 1942		July 1942 to June 1943	
	Lc. mygdon	*C. shackamaxon*	*Lc. mygdon*	*C. shackamaxon*
pH 4.0	.10	.40	.90	.30
pH 6.0	.30	.50	.90	1.80
pH 8.0	.20	.20	.80	.30

TESTS ON THE USES OF ADDITIONAL LIGHT

Light has two roles in the growth of plants. Light intensity is very important and can limit growth by being either too low or too high. The length of the light period also has a pronounced effect on the flowering period of certain plants. Light intenstiy has little to do with this reaction, the duration of the light during the day being the controlling factor. It is known that orchids respond to the first of these light factors, light intensity, but little is known about the second, photoperiodism.

After receiving many inquiries as to the use of artificial light on orchids during the winter months, a test was started to find if this additional light would be of value. Also, the test included an attempt to find the specific effect light intensities might have on both vegetative and reproductive growth.

Four hybrids, *C. higos*, *Lc. morvyth*, *Lc. aphrodite*, and *Lc. tartan*, were placed under three light-intensity levels—low, normal, and high. Plants under normal intensity were placed out in the greenhouse with the usual amount of shading on the roof. Plants under low light intensity were placed under an additional cheesecloth shade. Plants under high light intensity were lighted by two 200-watt bulbs placed 15 inches from the plants and turned on 8 hours a day when the temperature stayed below 80° F. The light intensities varied with the seasons and the outside weather conditions, but averaged 184 candlefoot power for the high-light plot, 140 candlefoot power for the normal plot on a sunny day, and 52 candlefoot power under the low-light plot.

TABLE 10.—The average leaf area increase per plant in square centimeters

	C. higos	*Lc. morvyth*	*Lc. aphrodite*	*Lc. tartan*	Total averages
Low light	8.6	6.7	2.4	14.7	8.6
Normal light	17.2	17.8	0.0	5.9	11.9
High light	22.3	8.6	0.0	103.5	30.9

Table 10 gives the average gain per plant in leaf area and table 11 gives the average flower production per plant, for the first year. The growth corresponded with the light intensity, smallest gain under the low light intensity, and most gain under the high light intensity. The same statement is generally true for flower production. At the end of a year, two hybrids, *C. higos*

and *C. tartan*, were retained while the other two were eliminated as they were poor at the beginning of the experiment. Table 12 shows the results of the second year on these two remaining hybrids and shows that the same general statement of better production under the high light intensity still applies. The plants under high light intensity were much lighter green in color and were very hard growth. Those grown under the low light intensity were soft, the new growths were very weak, and the whole plant was very dark green.

TABLE 11.—Average flower production per plant for the first year

	C. higos	*Lc. morryth*	*Lc. aphrodite*	*Lc. tartan*	Total averages
Low light	.22	0.0	.75	.50	.33
Normal light	0.0	0.0	.25	1.00	.23
High light	.55	0.0	0.0	1.50	.52

TABLE 12.—Average flower production per plant for the second year

	C. higos	*Lc. tartan*	Total averages
Low light	.35	.25	.46
Normal light	1.11	1.50	1.23
High light	1.00	2.30	1.38

In attempting to find if Cattleya orchids would respond to a change in length of day, a test was set up in conjunction with the test on the addition of a fertilizing solution, previously discussed. Three day-length periods were used, long day of 15 hours, short day of 10 hours, and a normal day which would vary with the seasons. This manipulation was carried out by the use of black shading cloth and additional lights.

After a year's test, there was no change in increasing or changing the flower production of these plants, *C. higos*, *C. chico*, and *C. pinole*. There is either no definite photoperiodic effect, or, if so, the right conditions were not fulfilled in this experiment.

In conclusion, it may be stated that much scientific work must be carried on before the physiology and anatomy and their practical applications can be as thoroughly understood and applied as they are known and used in producing other floral crops. Much of the work can only be done by persons and institutions so prepared, but they must be aided by interested growers as to advice, suggestions, and materials. Many of the orchid growers over the country have generously provided plants for the work herein reported. As much of the present work as is possible is being continued despite handicaps, so that several years' records may be used for more valuable conclusions.

FURTHER OBSERVATIONS ON THE CONTROL OF TOMATO ANTHRACNOSE

J. D. WILSON

Results obtained in 1942 (1) indicated that good control of the anthracnose fruit rot of tomato, caused by *Colletotrichum phomoides* (Sacc.) Chester, could be obtained with Fermate if the applications were properly timed and if the first treatment was made rather early in the season when the fruits of the first cluster were little more than half grown. The data of 1943 have helped to confirm this.[1] Various copper-containing fungicides have failed frequently in past years to give satisfactory control of anthracnose (1, 2) even when leaf-spot control was good. They failed again in several instances in 1943, and it now seems likely that they can be discarded as possible control materials for this disease.

Experiments were specially designed in 1943 to study the influence of variations in timing, amount, and concentration of Fermate sprays on the degree of disease control obtained. Also, copper was mixed with Fermate, and alternated with Fermate, in an effort to secure still better control of defoliation by leaf spots without interfering with the control of fruit rot. The amount of anthracnose was carefully noted in several other tomato spraying experiments on the chance that other things of possible significance in the control of this disease might be observed.

A rather definite relationship has been observed to exist between defoliation (3), either from leaf-spot attack or spray injury, and the percentage of fruits affected with anthracnose. The heavy infection of the Huelsen variety shown in table 1 followed a severe defoliation of the plants by Alternaria blight. It seems likely that excessive exposure of the fruits to the sun following defoliation must injure the epidermis in some manner that facilitates infection. Also, certain chemical changes may occur in sunburned fruits that encourage the rapid development of the fungus following initial penetration. When defoliation was well controlled early in the season, as it was by the June 30-August 9 spray schedule, the amount of anthracnose was reduced considerably below that in the heavily defoliated check plots, or those sprayed on the July 30-September 8 schedule. This was also noted for the Baltimore variety. Stokesdale and Rutgers were not defoliated as much as Huelsen and Baltimore and their fruits were not as severely attacked by fruit rot. In fact, Rutgers, in this experiment, seems to run contrary to the rest of the group with respect to the timing of the spray schedule. However, the Rutgers plants that were treated on the June 30-August 9 schedule were actually defoliated by leaf spot to a greater extent than were those included in the later spray schedules, and this defoliation possibly did encourage the heavier infection that occurred.

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[1]The author wishes to acknowledge his indebtedness to Dr. O. S. Cannon, of the H. J. Heinz Co., and to Mr. Harry Stout, both of Bowling Green, Ohio, for their assistance in these studies on anthracnose control during the summer of 1943.

(1). Wilson, J. D. 1942. Preliminary results on the control of tomato anthracnose. Ohio Agr. Exp. Sta. Bimo. Bull. 28: 34-37.

(2). McNew, G. L. 1943. New spray controls anthracnose of tomato fruit. Farm Research 9 (1): 6-7.

(3). Hunter, H. A. 1933. Diseases of canning crops in Maryland in 1933. Plant Disease Reporter 17: 183.

TABLE 1.—Influence of spray timing (COC-S at 4½-100) on the control of anthracnose on the fruits of four tomato varieties

Data are average percentages of fruits affected in pickings made on September 10 and 17

Dates of treatments	Huelsen	Stokesdale	Baltimore	Rutgers
No treatment	43 5	11.6	32.2	12.4
June 30–Aug 9	22 7	4 9	12.2	7.8
July 10–Aug. 19	26 9	5.7	13 0	6.1
July 20–Aug. 29	28 0	7.3	13 6	5.9
July 30–Sept. 8	34 7	9.1	21.1	5.1

The influence of spray injury on the prevalence of anthracnose is shown by some of the data in table 2. A special form of Bordeaux mixture prepared with nickel sulfate was quite injurious to tomato foliage, and anthracnose on plots treated with this material was even more common than in the untreated checks. This was also true for plants treated with certain experimental organic materials and a specially prepared copper material, all of which caused foliage injury. The comparatively mild injury to tomato plants that is commonly caused by Bordeaux mixture may be in some measure responsible for the fact that this material does not afford particularly good controi of anthracnose. A mixture of Nufilm (an adhesive) and COC-S was slightly injurious (see table 3), and again the percentage of anthracnose present on the fruits was greater than with comparable sprays that did not injure the plants. Casual observation during the grading operation has consistently shown that badly sunburned fruits and fruits that were inadvertently detached from the parent plant before they were ripe were very likly to become infected with anthracnose as they ripened.

TABLE 2.—Influence of various treatments on the percentage of Stokesdale fruits affected with anthracnose rot in the picking of September 8, 1943

Treatments	Anthracnose	Treatments	Anthracnose
	Per cent		*Per cent*
Tribasic (4-100)	7.8	Bordeaux (8-8-100)	6.5
Tribasic+calcium arsenic(4-4-100)	2.7	Tribasic+Loomkill (14-86)	5.0
Tribasic+derris (4-4-100)	8.3	Cuprocide+Loomkill (8-100)	3.6
Tribasic+sulfur (4-4-100)	4.1	COC-S+Loomkill (16-100)	7.2
Cuprocide (2-100)	7.4	Nickel Bordeaux (4-4-100)	23.6
COC-S (4½-100)	8.4	An experimental organic	22.1
Fermate (2-100)	0.3	Bonded copper	15.9
Bonded sulfur	4.8	No treatment	14.0

Another interesting and somewhat intriguing feature of the 1943 results was the seemingly long period of protection against anthracnose infection that existed following the cessation of treatment, especially in the early application schedules. In table 1, the Huelsen and Baltimore plots that received their first treatment on June 30 and their last on August 9 were still producing a higher percentage of anthracnose-free tomatoes on September 10 and 17 (or 32 and

39 days later) than were those treated on any later schedule. Furthermore, the percentage of disease became progressively greater as the schedule of treatments approached more closely to the picking dates (July 20 to September 8, etc.). The same relationship between the prevalence of fruit rot and the timing of the spray schedules exists in the data of table 4. In the Rutgers plots the protection against anthracnose on September 22, or 33 days after the last treatment, was better for the early schedule than for any later one. This condition continued even up to 40 and 50 days (on September 29 and October 12) after the last treatment was made in the early schedule. This post-treatment protection did not carry over for as long a period on Huelsen, but this was at least partly due to the fact that leaf defoliation and sunburn became severe by mid-September. Treated plots of Baltimore and of the San Marzano hybrid, especially those that received the two earliest spray schedules, showed at least a 60 per cent reduction in anthracnose at 38 and 40 days after treatment. Fermate dust (table 5) reduced the amount of fruit rot from 52 per cent in the untreated plots to 8 per cent in a picking made 39 days after the last treatment.

TABLE 3.—Effect of various Fermate and COC-S sprays on the reduction of anthracnose rot on the fruits of a San Marzano hybrid at Wooster in 1943

Treatments	Seasonal average of affected fruits	Treatments	Seasonal average of affected fruits
	Per cent		*Per cent*
Fermate (2-100) started Aug. 6	14.0	Fermate+COC-S (2-4½-100)	20.9
Fermate (2-100) started Aug. 13	18.5	Fermate & COC-S alternating	22.6
Fermate (2-100) started Aug. 20	20.5	COC-S (4½-100)	27.5
Fermate (1-100)	18.4	COC-S+Nufilm (4½-1-100)	30.0
Fermate (3-100)	16.2	No treatment	40.6

The length of this post-treatment protection period suggests that two and possibly three things may play a part in control. Early sprays may reduce primary infections on the fruit or even on vegetative parts (if these can conceivably occur) to a minimum, and they may also partially sterilize the soil surface, thus keeping the inoculum for later infection at a minimum. On the other hand, it is barely possible that the tomato plant absorbs something from the Fermate that increases the resistance to the penetration and development of the fungus.

The proper timing of the spray schedule is perhaps even more important in the control of anthracnose fruit rot of tomato than it is in checking defoliation due to leaf-spot infection. The data obtained at Wooster in 1942 (1) had indicated that the first spray should go on no later than the latter part of July, or when the fruits of the first cluster were about one-half to three-fourths of full size. In general, the data of 1943 have confirmed this. However, the results given in table 1 show that the timing of the spray schedule must be altered somewhat with different varieties to obtain the best control of anthracnose. This has also been found to be advisable in various instances in the control of leaf spot (4) and, if excess defoliation encourages the development of anthracnose, it is likely that the control problems are related in this respect.

(4). Wilson, J. D. 1943. Tomato varieties and the timing of spray schedules. Ohio Agr. Exp. Sta. Bimo. Bull. 28: 75-82.

TABLE 4.—Relationship between spray timing and the period of effective control of tomato anthracnose following the last application

Dates of treatments	Baltimore			Rutgers			San Marzano hybrid			Huelsen	
	Picking on — —			Picking on — —			Picking on — —			Picking on — —	
	Sept. 22	Sept. 29	Oct. 12	Sept. 22	Sept. 29	Oct. 12	Sept. 22	Sept. 29	Oct. 12	Sept. 15	Sept. 22
July 23-Aug. 20	9.3	10.5	40.7	6.4	11.5	35.9	17.7	12.5	38.6	16.8	52.6
Aug. 5-Sept. 5	7.9	15.2	23.9	15.8	19.2	39.1	14.8	4.7	26.4	25.6	52.6
Aug. 20-Sept. 5	19.7	20.6	50.7	20.3	40.8	40.1	11.0	13.9	50.2	56.9	90.0
No treatment	54.2	68.5	82.8	46.5	64.4	86.0	50.4	51.4	85.1	55.6	100.0

A spray schedule that did not start before July 30 was definitely too late to give satisfactory control of anthracnose on the Huelsen, Stokesdale, and Baltimore plots. The July 2 schedule was not significantly poorer than that of July 10. The difference in maturity dates for different varieties of tomatoes and the same variety planted on different dates, as well as the lateness or earliness of the crop in different years, indicates that perhaps the spray schedule should be timed to correspond with a certain stage of plant or fruit development rather than to start on any specific date.

TABLE 5.—Comparison of sprays and dusts for anthracnose control on Baltimore tomatoes at Bowling Green in 1943

Treatments	Percentage of fruits diseased		
	October 13 picking	Last five pickings	Entire season
No treatment	52.4	42.7	31.4
Cuprocide (2-100)	26.9	13.7	10.0
COC-S (4¼-100)	28.7	14.1	9.7
Tribasic (4-100)	31.4	21.9	16.0
Fermate (2-100)	17.7	8.1	5.8
Tribasic+E M talc (14-86)	25.0	18.9	13.9
Fermate+E M talc (10-90)	8.0	6.5	4.6

TABLE 6.—Degree of anthracnose control obtained with various sprays and dusts on four tomato varieties at Bowling Green in 1943

Treatments*	Percentage of fruits affected for the season				
	Huelsen	San Marzano hybrid	Baltimore	Rutgers	Average of all four varieties
Fermate (2-100) started July 23	24.1	14.3	11.9	12.0	15.4
Fermate (2-100) started Aug. 5	28.1	11.4	11.4	15.5	16.2
Fermate (2-100) started Aug. 20	55.0	23.2	30.6	22.5	27.7
Fermate (2-100) 200 gal. per A.	27.6	9.2	8.0	13.0	14.5
Fermate+COC-S (2-4¼-100)	29.4	17.6	13.5	16.9	19.3
Fermate and COC-S alternating	26.6	14.1	10.0	17.7	17.1
COC-S (4¼-100)	33.0	20.6	35.9	30.6	30.1
Fermate+E M talc (10-90)	23.8	12.6	9.6	9.4	13.5
COC-S+E M talc (16-84)	49.5	34.8	28.1	33.7	35.4
No treatment	50.4	39.9	34.8	44.0	42.4

*All sprays applied at 140-150 gallons per acre, except as noted, and the two dusts at 40 pounds per acre. All treatments started on August 5 except as noted.

The data of table 3 that refer to timing of the spray schedule again emphasize the importance of starting early enough when one wishes to control anthracnose. August 6 was a better date than any later one, but even this was too late in this experiment since many of the fruits on the first cluster were ripe on that date and the disease had already appeared on some of them. The data of table 4, and their counterpart in table 6, show little difference between the starting dates of July 23 and August 5. August 20 was again too late in all instances. These data on timing for the different tables as a group are similar to those of last year (4) in so far as they indicate that a spray application made specifically for the purpose of controlling anthracnose fruit rot of tomato should not be too long delayed, probably not much beyond August 1 for most varieties and most plantings during the average season in Northern Ohio.

Only limited data were obtained in 1943 on the relative value of various concentrations and on rates of application of spray and dust materials in the control of anthracnose. This is also true with respect to the number of applications and the length of the time interval between them. Some of the data in table 3 deal with the matter of concentration, but the differences in control when 1, 2, and 3 pounds of Fermate were used in 100 gallons of water were not significant in this instance, although 3-100 did give the best control. When 200 gallons of a 2-100 Fermate spray were compared with 150 gallons (second treatment from the top of table 6), the average percentages of disease were 14.5 and 16.2 per cent, respectively, and these relative values existed for all four varieties.

The comparative effectiveness of Fermate and various copper-containing formulas may be compared in the data of tables 2, 3, 5, and 6. In table 2, the average percentage of fruits affected with anthracnose on September 8 on three series of plots sprayed with fixed coppers was 7.9; whereas only 0.3 per cent were infected on the plants treated with Fermate. In the experiment analyzed in table 3, the plots treated with Fermate and COC-S showed 18.5 and 27.5 per cent, respectively, of diseased fruits. When Baltimore tomatoes at Bowling Green were sprayed with Fermate (table 5), 5.8 per cent of all the ripe fruits produced were affected with anthracnose; whereas the average for three fixed copper sprays was 11.9 per cent. In this same experiment, plots dusted with Fermate and Tribasic showed 4.6 and 13.9 per cent of affected fruits, respectively. In the data of table 6, the results were similar. The average amount of anthracnose in the fruits of four varieties that were sprayed with Fermate was 16.2 per cent and the value for a COC-S spray treatment was 30.1 per cent, or almost twice as large a percentage of fruits were affected when copper was used.

When a fixed copper and Fermate were mixed in the same tank, the control of anthracnose was not as good as that obtained with Fermate alone. In table 3, the respective values were 20.9 and 18.5 per cent, and in table 6 they were 19.3 and 16.2. This was rather disappointing since it would be a decided advantage if a single mixture such as this one could be used to obtain the maximum control possible of leaf spot and anthracnose.

On the further chance that a fixed copper and Fermate could be combined on the same plants, the two materials were alternated in their application at Wooster and Bowling Green. This combination was not as effective as Fermate alone, however, as may be seen from the data of tables 3 and 6. At Wooster, the respective percentages of affected fruits were 18.5 and 22.6 for Fermate used alone and Fermate and COC-S used alternately, and at Bowling Green the percentage values were 16.2 and 17.1. Since neither the single mixture nor the alternating schedule was as successful in the control of anthracnose as Fermate alone, it is likely that a schedule involving two applications of a fixed copper in July and three of Fermate in August will be compared with other treatments in 1944. Also, the possibility of using supplemental materials with copper will be further investigated. The use of calcium arsenate and of sulfur with Tribasic (table 2) reduced the percentage of diseased fruits to a considerable extent.

Finally, the comparative effectiveness of sprays and dusts in the control of anthracnose is shown in tables 2, 5, and 6. In table 2 the average percentage of affected fruits on three series of plots sprayed with fixed coppers was 7.9; whereas on plots dusted with the same materials, the average was 5.3 per cent. In table 5, plots sprayed and dusted with Fermate showed a seasonal average of 5.8 and 4.6 per cent of diseased fruits, respectively. Comparable values for Tribasic spray and dust were 16.0 and 13.9, respectively. When the results on four varieties were averaged in table 6, Fermate spray and dust showed respective percentages of diseased fruits of 16.2 and 13.5, and the values for COC-S spray and dust were 30.1 and 35.4 per cent, respectively. Thus, in five comparisons between sprays and dusts, dusting gave the best control in four instances. The reason for this is not immediately apparent since spraying is generally somewhat more effective in leaf-spot control than is dusting.

CONCLUSIONS AND SUMMARY

Tomato spraying experiments were specially designed in 1943 to study the influence of variations in the timing of the spray schedule on the control of tomato anthracnose. Fermate sprays were varied in concentration and the amount applied per acre. Copper was used alone in certain sprays, mixed with Fermate and alternated with Fermate, in an effort to get a little better control of leaf spots than that obtained with Fermate only, without at the same time sacrificing anthracnose control. Also, several other tomato spraying experiments were observed during intervals of heavy anthracnose appearance in an effort to discover other things of possible significance in its control.

Severe defoliation by early blight encouraged a heavy infestation of anthracnose on Huelsen, especially on sunburned fruits. Control of defoliation by early copper sprays helped to reduce this type of infection. Sprays that caused host injury seemed to encourage infection of the fruits by anthracnose. This was probably due in part to an injury of the epidermis of the fruit, and possibly infection was favored by partial defoliation that accompanied injury.

Post-treatment protection against anthracnose was found to carry over for a longer period with comparatively early spray schedules (July 20 to August 30) than with later treatments. A decided reduction in the percentage of ripe fruits that showed anthracnose lesions at picking time was obtained even 50 days after the last treatment was made in an early spray schedule. This is of considerable interest since 50 days is approximately the period that elapses between pollination and ripening of the tomato fruit. The length of this period over which the disease is reduced by early spray schedules suggests that any reduction in primary inoculum is important. This may be accomplished by a partial sterilization of the surface soil and by a reduction in any primary infection that may occur on early fruits, or even possibly on vegetative parts. Also, the seemingly long lasting protection may result from the absorption of some factor from the spray material that retards the penetration and the later development of the fungus in the tissue of the fruit.

The timing of the spray schedule should be altered somewhat on early- and late-maturing varieties to get the best results. This suggests that perhaps the stage of fruit development should be accepted as the criterion. On this basis the first spray application should be made when the fruits of the first cluster are one-half to three-fourths their normal size when ripe.

The results obtained in 1943 on the proper concentration of the fungicide (particularly Fermate) to use for the best and most economical control were inconclusive, although Fermate 3-100 gave somewhat better results than weaker formulas.

The data on gallonage were also of little value in an effort to determine the proper application. In one experiment the differences between 150, 200, and 250 gallons per acre were not significant.

Copper-containing fungicides were definitely less effective than Fermate in controlling anthracnose and neither were they wholly successful when mixed with Fermate in the same tank or alternated with it in successive applications.

The use of certain supplemental materials with fixed coppers to obtain better control of fruit rot was encouraging and should be investigated further.

Sprays and dusts gave comparable results in the control of anthracnose.

On the basis of 2 years of experience in trying to control tomato anthracnose, it seems likely that the most satisfactory results should be obtained by spraying (2-100) or dusting (10-90) with Fermate on a schedule of five treatments at 10-day intervals in which the first application is made when the fruits of the first cluster are approximately two-thirds developed.

TEN YEARS OF CARROT SPRAYING WITH VARIOUS COPPER-CONTAINING MATERIALS

J. D. WILSON

The leaf blights of carrot caused by *Cercospora apii carotae* Pass. and *Macrosporium carotae* Ell. and Lang. (1, 2, 3) have become increasingly common in Ohio during the past 15 years. One or both of these diseases now cause considerable loss each year in home gardens and commercial plantings. Many growers spray all but their earliest plantings to reduce the losses in yield and quality that follow defoliation. Good control of these diseases was obtained with an 8-12-100 Bordeaux mixture in a single instance in 1932 (4). The yields of the sprayed and untreated plots were 22.7 and 13.6 tons per acre, respectively. Since that time additional experiments have been conducted

1. Doran, W. L., and E. F. Guba. 1929. Blight and leaf-spot of carrot in Massachusetts. Mass. Agr. Exp. Sta. Bull. 245, 271-278.

2. Thomas, H. R. 1943. Cercospora blight of carrot. Phytopath. 33: 114-125.

3. Newhall, A. G. 1936. Carrot blight investigation. Mimeographed report to Santa Maria Valley Pest Control Association.

4. Wilson, J. D. 1933. Spraying carrots for the control of leaf diseases. Ohio Agr. Exp. Sta. Bimo. Bull. 18: 2-4.

nearly every year at one or more points in Ohio (5, 6, 7, 8, 9). Most of these have involved comparisons between one or more of the fixed copper compounds and Bordeaux mixture. A randomized distribution of small plots with each treatment applied to five replicates has been used whenever possible. The applications were made at 10-day intervals unless otherwise noted and continued from the time the tops were about 4 inches high until about 2 weeks before the crop was to be harvested.

Carrots are comparatively susceptible to spray injury, but in contrast to such vegetables as tomatoes and cucurbits (10, 11, 12, 13) they are more likely to be injured by the fixed coppers than Bordeaux mixture of comparable copper equivalent. Medium concentrations of copper have been used in all of these experiments on carrots in an effort to avoid excessive host injury, and all of the copper compounds have been used in such quantities that the amount of copper (as the metallic equivalent) present in the various formulas was the same. If defoliation by the leaf diseases is severe, it is possible to obtain yield increases of 25 per cent by spraying with the proper materials, but, if disease does not appear in a sprayed planting, yields may be reduced by a similar percentage because of injury with various spray materials, particularly some of the fixed coppers (7, 11).

TABLE 1.—Effect of various spray materials on the yield of upland carrots at Elyria in 1936 and 1937

Treatments	1936	1937
	Tons per acre	*Tons per acre*
Cupro-K + flour (8-8-100)	....	13.95
Coposil + flour (8-8-100)	15.8	12.60
Copper Hydro 40 + flour (8-8-100)	....	12.45
Bordeaux mixture (8-8-100)	17.4	12.15
Copper A + flour (5-8-100)	15.5	12.00
No treatment	14.2	8.55
Cuprocide 54 (4-100)	....	8.40
Super Copper (1-200)	....	7.20
Difference required for significance at the 5 per cent level	....	1.79

A fixed copper (Coposil) and Bordeaux mixture were applied to carrots at McGuffey in 1935. The stand was rather uneven in the various plots and for that reason the comparative yields obtained were considered to be of little significance. However, the treated plants did yield approximately 50 per cent more carrots by weight than those that were left untreated. The degree of

5. Wilson, J. D. 1938. Insoluble copper compounds for spraying vegetables. Proc. Ohio Veg. Growers' Assoc. 23: 35-41.

6. Wilson, J. D. 1939. New equipment and new materials for controlling vegetable diseases. Proc. Ohio Veg. and Potato Growers' Assoc. 24: 110-134.

7. Wilson, J. D. 1940. Further studies on the use of fixed copper compounds in controlling vegetable diseases. Proc. Ohio Veg. and Potato Growers' Assoc. 25: 75-86.

8. Wilson, J. D. 1941. Further studies on the use of fixed copper compounds for the control of vegetable diseases. Proc. Ohio Veg. and Potato Growers' Assoc. 26: 20-33.

9. Wilson, J. D. 1942. The fixed coppers on vegetables in 1941 with special reference to the influence of supplemental materials. Proc. Ohio Veg. and Potato Growers' Assoc. 27: 61-75.

10. Wilson, J. D., and H. A. Runnels. 1938. Insoluble copper compounds as vegetable sprays. Ohio Agr. Exp. Sta. Bimo. Bull. 23: 48-55.

11. Wilson, J. D. 1940. Certain injurious effects of spraying vegetables with the fixed coppers. Ohio Agr. Exp. Sta. Bimo. Bull. 25: 36-43.

12. Wilson, J. D., and H. A. Runnels. 1933. Some detrimental effects of spraying tomatoes with Bordeaux mixture. Ohio Agr. Exp. Sta. Bimo. Bull. 18: 4-15.

13. Wilson, J. D. 1935. Bordeaux mixture substitutes on cucurbits. Proc. Ohio Veg. Growers' Assoc. 20: 8-14.

disease control obtained may be judged by comparing the upper (untreated) and lower (Bordeaux treated) sections of figure 1. The respective yield of tops from these two sections was approximately 2 and 5 tons per acre at harvest.

Carrots were sprayed at Elyria in 1936 and 1937. Various fixed coppers were compared with Bordeaux mixture and the results obtained are given in table 1 (10).

In 1936 neither of the fixed coppers used (Coposil and Copper A) gave results equal to those obtained with Bordeaux mixture. Defoliation was not very severe, but in spite of this the best treatment increased the yield 3.2 tons per acre, or about 22 per cent over the untreated plants. In 1937 the situation was somewhat different. Defoliation was severe and all treatments but one gave a significant increase over the untreated plots. Super Copper (a liquid) injured the foliage considerably and decreased the yield, although it did give some measure of disease control. The injury caused by Cuprocide 54 (4-100) also offset the effect of disease control, with a resultant decrease in yield that was not significant. Of the remaining fixed coppers, three were not much different from Bordeaux mixture but Cupro-K did give a yield increase that was significant. However, Cupro-K failed to maintain this advantage over Bordeaux mixture in later trials.

TABLE 2.—Influence of various treatments on the yield of muck-grown carrots during a year (1938) when defoliation due to blight was not serious on untreated plots.

Treatments	Yield in tons per acre		
	Mid-season planting, McGuffey	Late planting, McGuffey	Orwell
Bordeaux mixture (6-6-100)	27.50	26.67	32.67
Coposil + flour (6-6-100)	23.81	27.50	31.41
Copper A + flour (3½-6-100)	25.99	25.83	31.50
Cupro-K + flour (6-6-100)	27.00	23.52	31.23
Cuprocide R + flour (2-6-100)	27.25	....	30.91
Tribasic + flour (3-6-100)	....	....	31.14
Copper 34 + flour (4½-6-100)	28.31	25.70	....
Super Copper (1-200)	23.66	24.36	....
No treatment	24.64	24.15	....
Difference required for significance at the 5 per cent level	1.98	2.31	....

Several fixed coppers were compared with Bordeaux mixture in three different plantings of carrots on muck soils in 1938. The results are given in table 2. Defoliation was not severe in two of the plantings and, as a result, differences in yield were not significant. When five fixed coppers and Bordeaux mixture were applied to a mid-season planting of carrots at McGuffey, the average increase in yield over the untreated plots was about 2.0 tons per acre, or 9.0 per cent. The yield increases were significant with three fixed copper compounds and Bordeaux. Four of the fixed coppers did not differ significantly from Bordeaux mixture, but the fifth (Coposil) was poorer in this experiment. Super Copper again caused sufficient injury to decrease the yield. The results were similar on a late planting of carrots. In this experiment only one fixed copper and Bordeaux gave yields significantly better than the check. Coposil was one of the poorest on the early planting but ranked first on the

late planting. The reason for this was not apparent. No untreated check plot was included in a series of treated plots at Orwell. Infection was not severe on any of the treated plots, which included five fixed coppers and Bordeaux. If the least difference necessary for significance was approximately similar to the McGuffey experiments (2.0 tons per acre), then one treatment was not significantly better nor poorer than another.

TABLE 3.—Comparative yields of carrot plots when treated with various fixed copper compounds in the presence and absence of disease (1939)

Treatments	Disease present, McGuffey	Disease absent, Elyria	Disease absent, McGuffey
	Tons per acre	*Tons per acre*	*Tons per acre*
Bordeaux mixture (8-8-100)	32.61	19.49	17.40
Tribasic + flour (4-8-100)	32.25	15.75	17.00
COC-S + flour (4-8-100)	......	14.95	17.20
Copper A + flour (4½-8-100)	30.89	16.54	18.00
Cuprocide 54-Y (4-100)	30.72	9.48	16.00
Cupro-K + flour (8-8-100)	29.40	......	......
Copper Hydro 40 + flour (8-8-100)	......	16.49	17.60
Basic copper arsenate + flour (4½-8-100)	31.40	......	......
Brown cupric hydrate + flour (3-8-100)	27.37	......	16.30
Coposil + flour (8-8-100)	......	11.61	......
No treatment	23.81	22.70	18.00
Difference necessary for significance at the 5 per cent level	2.49	1.52	1.73

The data for 1931 are given in table 3. They are of special interest because of the emphasis which they place on the relationship between host injury and disease control as this affects yield. Both Macrosporium and Cercospora were present on a mid-season planting of carrots at McGuffey. All of the seven treatments used in this series of plots gave a significant increase in yield over untreated plants. Bordeaux mixture gave good disease control and the highest yield of any treatment. However, the yield was not significantly better than that furnished by several of the fixed coppers. When many of the same treatments were used on a later planting of carrots at McGuffey where blight infection was slight, the yield was decreased. However, this decrease was significant only for Cuprocide and Brown Cupric Hydrate. Many of the same treatments were used in a planting that proved to be nearly free of disease on a sandy loam at Elyria. Yield reductions from treatment were serious and significant in every instance. Even Bordeaux mixture, which causes little if any visible host injury on carrots in most instances, caused a considerable decrease in yield below that of untreated plots. Tribasic, another comparatively "safe" copper compound, gave a 30 per cent reduction in yield. The data of table 3, as well as those from certain other experiments indicate that spray injury to carrots may be more severe on upland than on muck soils.

The materials listed in the last column of table 3 were also applied to carrots as dusts in 1939. Little was learned concerning the relative disease control of sprays and dusts from this experiment, since infection by blight was not severe enough to affect yields. It was found, however, that all of the materials caused a greater yield reduction because of injury when used as dusts than as sprays, with the exception of COC-S and Tribasic. The yields from the sprayed and dusted plots were practically equal for these two materials. This experiment and another similar comparison made previously failed to indicate a preference between the dusting or spraying of carrots for the control of Macrosporium and Cercospora leaf blights, but spraying has been used at McGuffey largely as a matter of convenience during the last 10 years. The recent acquisition of a self-propelled sprayer-duster unit will now make it possible to continue with a detailed comparison of the two methods with calibrated and regulated applications.

In 1940, when defoliation from blight was not an important factor in decreasing yields at McGuffey, only three of seven fixed copper compounds gave significant yield increases in a mid-season planting (see table 4). In a later planting the situation was the same, but Brown Cupric Hydrate was displaced by Copper A. Tribasic and Basicop (4-6-50) maintained their position near the top of the list. Bordeaux mixture caused a significant increase in yield in the late planting after failing by a small margin to do so in the earlier one. Halving the copper content of the Tribasic spray formula decreased the degree of disease control, but the decrease in yield was not significant. A similar result was obtained by leaving the flour out of the Basicop formula. Disease control was also decreased by removing the spreader (Turgitol) from the COC-S formula, but again the decrease in yield was not significant. All treatments increased the yield over no treatment in the late planting, but two of the fixed-copper plots yielded less than the check in the mid-season planting.

Each of four fixed copper compounds decreased the yield of carrots at Elyria where the leaf blights were absent in 1940. The average decrease in yield due to injury was 10 tons per acre, or 33 per cent. The decrease caused by Cuprocide Y (2½-6-100) was significantly greater than that due to the basic sulfates.

The data of tables 3 and 4 indicate that injury to the host and fungicidal efficiency must be balanced for the best results. If injury is too great, then disease control is of little avail and its benefits are offset by the depressing effect of injury on yield. This balance seems to be even more important on carrots than on many other vegetables. For instance, Tribasic reduced the yield of carrots in a disease-free planting by 10 per cent and increased it 30 per cent in another where disease was plentiful. It is conceivable that the net increase of 30 per cent only occurred after a hidden decrease of 10 per cent had been overcome, in which case the actual increase due to disease control was approximately 40 per cent. Thus, a "safe" material with a moderate degree of fungicidal action may be responsible for a larger yield increase over untreated plots than another material that is both more injurious to the host and more effective as a fungicide. If this is true, it helps to explain the generally good results that have been obtained with the basic copper sulfates on carrots.

TABLE 4.—Comparative yields of carrots when treated with various fixed copper compounds, and the influence of a sticker, a spreader, and a decrease in the amount of copper in the spray formula (1940)

Treatments	Mid-season planting, McGuffey	Late planting, McGuffey	Mid-season planting, Elyria
	Tons per acre	*Tons per acre*	*Tons per acre*
Bordeaux mixture (8-8-100)	34.45	31.28	....
Tribasic (4-6-100)*	36.93	30.01	23.4
Tribasic (2-6-100)	34.50	29.15	....
Basicop (4-6-100)	35.32	30.97	....
Basicop (4-0-100)	33.76	29.10	....
Copper A (4-6-100)	33.89	30.84	23.0
COC-S (4-6-100)	34.36	29.45	23.7
COC-S (4-6-100, no spreader)	33.28	27.88	....
Cuprocide Y (2½-6-100)	30.32	28.01	20.6
Basic copper arsenate (4-6-100)	30.93	28.80	....
Brown cupric hydrate (2¾-6-100)	35.24	28.71	....
No treatment	31.76	27.22	32.8
Difference required for significance at the 5 per cent level	3.27	2.50	2.52

*Turgitol was used in all fixed copper formulas except that of Cuprocide Y and one of those that contained COC-S. Flour was used as an adhesive with all formulas except one of those that contained Basicop.

A mid-season crop of carrots was sprayed with COC-S, plus various supplemental materials, at McGuffey in 1941. The leaf blights were not severe but in spite of this most of the treatments gave yield increases that were significantly above those of the untreated plots, as may be seen in table 5. Bordeaux mixture gave the best results, as it frequently has in these experiments. The foliage condition and yields were similar for the remaining treatments, although the addition of Cal Zinc to COC-S was not beneficial, and the plots that received this mixture were the only ones that failed to produce a significant yield increase. Kolofog (a fused bentonite-sulfur mixture) was similar to wheat flour as a supplemental material with COC-S.

TABLE 5.—The influence of various supplemenal materials on the control of carrot leaf diseases at McGuffey in 1941

Treatments	Yield in tons per acre	Percentage of foliage still green at harvest
Bordeaux mixture (6-6-100)	30.10	80
COC-S + flour (3-4-100)	27.75	77
COC-S + Kolofog (3-2-100)	27.57	78
COC-S + Cal Zinc (4-2-100)	26.10	72
No treatment	24.53	60
Difference required for significance at the 5 per cent level	2.37	....

The study of supplemental materials was carried still further on a later planting of carrots in 1941. The results are shown in table 6. All of the combinations tested increased the yield significantly above the untreated check plots. Wheat flour, soya flour, and bentonite were not significantly different. In fact, none of the results obtained with these supplemental materials varied significantly from those obtained with wheat flour. The plots treated with COC-S plus Kolofog were greener than any of the others at harvest. This

mixture also gave good foliage protection in the earlier planting of 1941. Cuprocide Y furnished a fair degree of foliage protection but the yield of roots was not as high as that from the other treatments in the experiment. It was, however, significantly better than the check plots.

TABLE 6.—A comparison of various supplemental materials, used with COC-S on carrots at McGuffey in 1941. Disease moderately severe

Treatments	Yield in tons per acre	Percentage of foliage still green at harvest
COC-S + Turgitol (4-100) 300 cc	33.63	46
COC-S + G. S. + sticker (4-100) 300 cc	34.10	56
COC-S + R-54 sticker (4-100) 100 gm	36.45	63
COC-S + wheat flour (4-4-100)	34.63	65
COC-S + soya flour (4-4-100)	34.00	58
COC-S + bentonite (4-4-100)	34.80	65
COC-S + Kolofog (4-4-100)	35.28	80
Tribasic (complete) (4-100)	36.45	62
Cuprocide Y (2½-100)	32.97	58
No treatment	29.58	16
Difference required for significance at the 5 per cent level	2.55	....

In 1942 a number of fixed copper compounds were again applied to carrots at McGuffey. Two or three other materials were also included. The sprays were applied from August 4 to September 22 at 10-day intervals. Cercospora leaf blight had become severe by mid-September and the check plots were nearly defoliated by harvest on October 13, as may be seen from the foliage score given in table 7.

TABLE 7.—The influence of various fixed copper compounds, Fermate, sulfur, and Bordeaux mixture on the yield of carrots at McGuffey in 1942

Treatments	Yield in tons per acre	Percentage of foliage still green at harvest
Bordeaux mixture (8-8-100)	39.84	80
Tribasic (4-100)	37.52	58
COC-S (4-100)	38.00	53
COC (R & H) (4-100)	37.16	44
Cuprocide (2-100)	38.08	62
Cuprocide (1-100)	39.12	64
Fermate (3-100)	39.88	76
Copper hydro arsenate (8-100)	33.48	30
Wettable sulfur	32.48	26
No treatment	32.72	14
Difference required for significance at the 5 per cent level	4.64	....

Bordeaux mixture gave good disease control and a better (but not significantly better) yield than any of the fixed coppers that were used. The fixed coppers, with the exception of Copper Hydro Arsenate, did not differ significantly one from another. A 1-100 concentration of Cuprocide was slightly, but not significantly, better than a 2-100. The weaker formula gave a better balance between injury and disease control, and, as a consequence, the plots that were treated with it produced more carrots than those that received the 2-100 formula.

Wettable sulfur failed to give satisfactory disease control and must have caused at least some injury, since the plots treated with it yielded less than the untreated checks. Fermate was applied to carrots for the first time at McGuffey and the results were good. The yield was equal to that obtained with Bordeaux, although the foliage score was not quite so good. Disease control was excellent but a mild form of foliage injury resulted which seemed to reduce the chlorophyll content of the leaves.

Three fixed copper compounds, sulfur, and several organic fungicides were compared with Bordeaux mixture as carrot sprays at McGuffey in 1943. The leaf spots were not so severe as usual but most of the materials gave yield increases over no treatment that were significant (see table 8). Tribasic was similar to Bordeaux mixture in disease control and yield. Bordeaux was significantly better, on the other hand, than everything but Tribasic and COC-S. Cuprocide was again somewhat injurious at 2-100. Fermate did not compare with the other materials as favorably as in 1943. It gave good disease control but caused some foliage injury. Also, the crowns of the carrot roots were slightly affected so that crown rot (*Erwinia carotovora*) became more general than on the roots from untreated plots. Sulfur used alone again failed to give results comparable to those obtained with copper. He-175, a new organic chemically related to Fermate, gave rather promising results, although disease control was not as good as that obtained with the copper compounds.

TABLE 8.—Influence of various spray materials on disease control and yield of carrots at McGuffey in 1943

Treatments	Yield in tons per acre	Percentage of foliage still green 10 days before harvest
Bordeaux mixture (6-6-100)	24.37	80
COC-S (4½-100)	22.97	75
Cuprocide (2-100)	21.64	71
Tribasic (4-100)	24.02	76
Magnetic sulfur paste (10-100)	21.40	74
Agrinib (8-100)	21.64	62
He-175 (2-100)	22.21	63
Fermate (2-100)	21.98	78
No treatment	17.21	54
Difference required for significance at the 5 per cent level	2.02	....

A late planting of carrots at McGuffey was sprayed with a standard COC-S formula used at different time intervals (6, 9, and 12 days), and different concentrations (2¼, 4½, and 9 pounds per 100 gallons) were applied with the 9-day time interval. Defoliation from disease began when the plants were comparatively small and reached medium severity before harvest. All treatments gave yield increases significantly above untreated plots. The 6-day interval was not significantly better than 9 or 12 days. Both 4½ and 9 pounds per 100 gallons gave a significant increase over 2¼ pounds. The data of this experiment at least suggest that a time interval of 10 days between applications and a metallic copper equivalent of 2 pounds per 100 gallons (4½ pounds of COC-S) is close to the optimum recommendation for the control of carrot leaf spots.

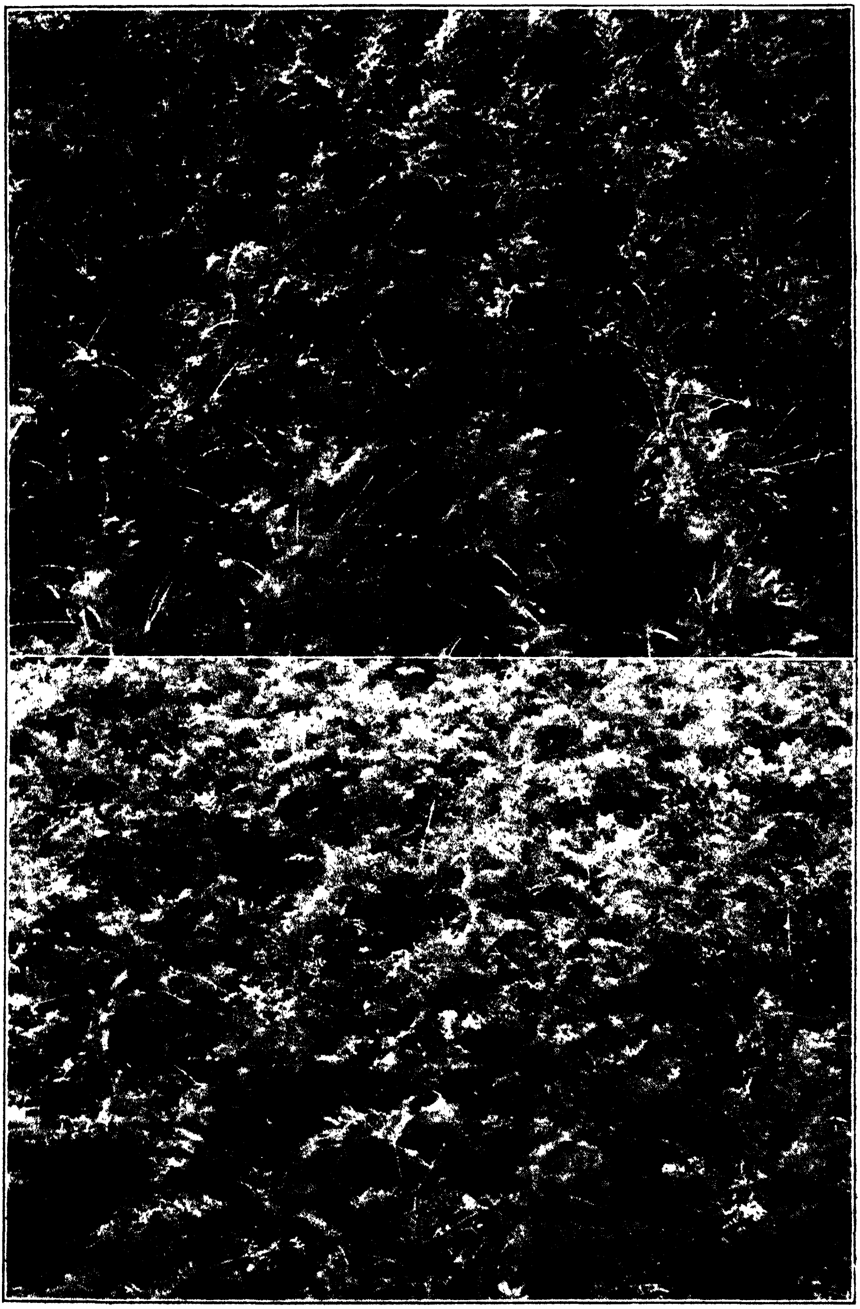

Fig. 1.—Foliage remaining on unsprayed (upper) carrots and those sprayed with Bordeaux mixture (lower) at harvest in 1935 at McGuffey.

SUMMARY

The Macrosporium and Cercospora leaf diseases of carrots have become increasingly common in Ohio during the last 15 years.

Bordeaux mixture and one or more of the fixed copper compounds have been used to spray experimental carrot plots for disease control at scattered points in Ohio during the past 10 years.

Small plots in randomized distribution have been sprayed at 10-day intervals with formulas that usually contained from 1½ to 2 pounds of copper (as the metallic equivalent) in each 100 gallons of spray material.

Carrots are comparatively susceptible to spray injury, especially by the fixed coppers, which usually caused reductions in yield when the leaf blights did not appear in these experiments.

Bordeaux mixture in an 8-8-100 or a 6-6-100 formula has consistently given results that were as good as those obtained from any of the fixed coppers or organic compounds that have been compared with it. In 13 of the experiments reported here, that have included both Bordeaux mixture and one or more of the fixed coppers, Bordeaux has been at the top seven times. It was better than Tribasic in seven of nine trials (significantly only once), better than Coposil in four of six trials, than Copper A in nine of ten comparisons (significantly only twice), than Cupro-K in five of six tests, than COC-S in seven of eight trials (significantly only twice), than Copper Hydro 40 in one of three experiments, and better than Cuprocide in all of the eleven comparisons (significantly five times) between these two materials.

Tribasic, which frequently gave good results on carrots apparently because of favorable balance between disease control and host injury, was better than COC-S in four of seven comparisons, than Copper A in four of nine trials, than Coposil in two of four tests, than Copper Hydro 40 in none of two trials, and better than Cuprocide in nine of ten experiments. The yield differences between plots treated with the various fixed coppers were seldom great enough to be statistically significant.

Plots treated with various forms of Cuprocide during a 7-year period failed in most of the experiments to yield as well as those treated with various other materials. This was not due to any lack of fungicidal efficiency but rather because of foliage injury. It seems likely that Cuprocide should not be used on carrots in concentrations comparable to those recommended for Bordeaux mixture or most of the fixed coppers. However, the balance between a lesser concentration and sufficiently good disease control is apparently narrow and rather difficult to determine.

Whenever 50 per cent or more of the carrot foliage on untreated plots had been killed from disease attack by the time the last spray was applied, Bordeaux mixture and many of the other materials used would show a significant increase in yield at harvest. If defoliation of the check plots was less than 10 per cent at harvest time, it was usually found that the treated plots showed a decrease in yield and that this decrease was significant for at least some of the materials used in each of three of the experiments reported where disease was scarce. Such reductions in yield were more marked on upland than muck soils.

In the 12 experiments reported here in which data were of such nature that they justified statistical analysis, the least significant difference in yields averaged approximately 10 per cent of the yield of the untreated plots. This was after adjustments for variations in stand had been made in a few instances. Six plantings made for experimental purposes during a period of 9 years were abandoned because of uneven stands, and the data of three or four of those finally used were of such nature that they could not be analyzed.

The weight of the carrot tops from treated plots was frequently two or three times as great as those from untreated plots. Crown rot was usually most common in untreated plots.

The use of wheat flour and other adhesives as supplements to carrot sprays seemed to be of questionable value, and for this reason they were omitted from many of the later experiments. Wetting agents were used throughout the test period. Fixed coppers such as Cupro K and Copper Hydro 40 were finally omitted because of general unavailability on the market and their comparatively high cost on the basis of metallic copper equivalent.

Spraying has been found somewhat more practical than dusting for the control of carrot leaf blights, although a sufficient number of comparisons between the two methods has not yet been made to rule out dusting from further consideration.

The range between disease control and host injury is apparently very narrow for carrots. Bordeaux mixture, which frequently injures tomatoes and cucurbits, is less likely to injure carrots than are many of the fixed coppers at comparable copper concentrations. This may be one reason that plots treated with it frequently outyield all others.

Fermate was used on carrots only during 1942 and 1943, but in those years it gave good control of the leaf blights. However, it caused a mild form of foliage injury which reduced its ability to increase yields through disease control. Other organic compounds tested have not proved outstanding to date. Sulfur has not given satisfactory disease control in the few tests made with it.

Limited tests have indicated that the copper content of carrot sprays cannot be decreased much below a metallic copper equivalent of 1½ pounds per 100 gallons. Neither is much gained by making the interval between spray applications less than 9 days.

Observations made during the progress of the experimental work reported here indicate that Bordeaux mixture (6-6-100) will give satisfactory control of carrot leaf blights. Also, many of the fixed coppers, particularly the basic sulfates, may be used (3 pounds in 100 gallons when the copper content is 50 per cent) if it is more convenient to the grower. About 150 to 175 gallons per acre should be used. The first application should be made when the tops are 4 to 6 inches high and this should be followed by others at 10-day intervals until about 2 weeks before the crop is to be harvested. A wetting agent should be used in most of the fixed copper sprays.

SOME TRENDS IN THE FARM REAL ESTATE SITUATION

H. R. MOORE

Enough similarity prevails between the current farm real estate market situation and the conditions existing in 1918-1920 to raise the question of impending land value inflation and its attending evils in the post-war period. The two most obvious similarities are: (1) the trend in land prices in both 1918-1920 and in 1941-1943 has been practically the same, advancing at the rate of about one per cent per month with some tendency for this rate to accelerate; and (2) the frequency of farm real estate transfers has been considerably above normal in both periods. On the other hand, an important difference is that the 1920 peak in land prices was the culmination of an advance which had persisted for almost 20 years; whereas the 1941-43 advance has so far only pulled land prices back to about the 1910-1914 level. If we may judge from the past, it is a fair assumption that present farm real estate prices on the average are not far out of line with the long-time level of prices in general. But it can likewise be assumed that the conditions exist which could rather quickly precipitate serious land price inflation and set the stage for a subsequent painful period of deflation.

In consideration of the above situation, a study is being made of farm real estate sales in a few sample counties to assemble information which will help to carify the circumstances attending farm real estate market activities. The following analysis is based on sales in three of these counties—Darke, Madison, and Muskingum.

Who is selling farm real estate?—In this three-county sample area approximately one-fourth (26 per cent) of the sellers during the past 2¾ years were active farmers at the time of sale. It is perhaps significant that the proportion increased from 18 per cent in 1941 to 30 per cent in the first 9 months of 1943. Retired farmers and widows were the sellers in 20 per cent of the transactions in 1941 and in 15 per cent in 1943. Heirs of estates sold 38 per cent of the farms in 1941 and 22 per cent in 1943. Sellers were non-farmers in 19 per cent of the cases in 1941 and in 27 per cent in 1943. Corporations, financial institutions, and governmental agencies accounted for 5 per cent of the farm sales in 1941 and for 6 per cent in 1943.

Who is buying farm real estate?—Individuals purchasing farms have been grouped according to occupational status before purchase. Farm owner-operators may purchase land to enlarge their existing farm units, as additional units, or for replacement of land sold. Purchases by owner-operators have increased in number but have remained fairly constant relative to the total number of tracts transferred, being 35 per cent in 1941, 31 per cent in 1942, and 32 per cent in 1943. Tenant farmers purchased 16 per cent of the tracts transferred in 1941, 22 per cent in 1942, and 28 per cent in 1943. Owner-operators and tenant farmers together purchased 55 per cent of the farm tracts transferred in the total 2¾-year period as compared with 45 per cent by non-farmers.

TABLE 1.—Sellers of farm real estate in a sample area of three Ohio counties, January 1, 1941 to September 30, 1943

Period		Active farmer	Retired farmer or widow	Estate	Non-farmer	Corporation	Total sales classified
1941	Number	47	52	101	51	14	265
	Per cent	18	20	38	19	5	100
1942	Number	97	78	108	61	21	365
	Per cent	26	21	30	17	6	100
1st 9 mo. 1943	Number	140	68	100	125	27	460
	Per cent	30	15	22	27	6	100
Total	Number	284	198	309	237	62	1090
	Per cent	26	18	28	22	6	100

Non-farmers were purchasers in 49 per cent of the transactions in 1941 but bought 55 per cent of the land, as compared with 40 per cent of the transactions in 1943 involving 35 per cent of the land. Evidently a greater proportion of non-farmers in 1943 have been buying small holdings suitable for part-time farming and a home in the country as contrasted with a full sized farm unit bought as an investment or to be operated personally. Tracts of less than 10 acres were not included in the sample. If these small acreages had been included, the proportion of non-farm buyers would be materially higher.

TABLE 2.—Buyers of farm real estate, sample area of three Ohio counties, January 1, 1941 to September 30, 1943

Period		Owner-operator	Tenant	Non-farmer	Total purchases classified
1941	Number	82	38	117	237
	Per cent	35	16	49	100
1942	Number	99	69	153	321
	Per cent	31	21	48	100
1st 9 mo. 1943	Number	124	111	157	392
	Per cent	32	28	40	100
Total	Number	305	218	427	950
	Per cent	32	23	45	100

Mortgage debt commitments of buyers.—The most serious consequences of land price inflation falls on those who are deeply in debt. It is desirable, therefore, to examine the mortgage debt commitments associated with recent farm real estate transfers. In the sample area being discussed it is found that owner-operators purchasing farm land during the past 2¾ years have given or assumed mortgages in 44 per cent of the transfers and in amount equal to 60 per cent of the average purchase price of tracts encumbered by mortgage. Tenant farmers buying land have mortgaged it or assumed mortgages in 83 per cent of the cases and in amount equal to 68 per cent of the purchase price. Non-farmers have given mortgages in 48 per cent of the cases and in amount equal to 60 per cent of the purchase price of the mortgaged land. Additional information is contained in table 3 on land purchases by these three groups of buyers.

TABLE 3.—Farm real estate transfers grouped according to occupational status of purchaser, and mortgage debt encumbering tracts following purchase, three county sample area, January 1941 to September 30, 1943

		Occupational status of buyer at time of purchase		
		Owner-operator farmer	Tenant farmer	Non-farmer
All tracts:				
Tracts purchased	Number	305	218	427
Total area	Acres	24,109.0	20,988.0	36,329.0
Average size of tract	Acres	79.0	96.3	85.1
Average price per acre	Dollars	73.29	72.70	74.61
Tracts encumbered with new or assumed mortgage debt:				
Tracts purchased	Number	135	182	206
Total area	Acres	12,398.0	17,877.0	17,971.0
Average size of tract	Acres	91.8	98.2	87.2
Average price per acre	Dollars	75 44	75.99	72.05
Average debt per acre	Dollars	45.58	51.85	42.91
Ratio of debt to purchase price	Per cent	60.4	68.2	59.6
Proportion of tracts encumbered with mortgage	Per cent	44.3	83.5	48.2

The general trend in loan policy is being influenced to some extent by rising land prices. The average amount per acre being loaned has increased 75 per cent as much as the price of land has increased, as indicated by the average purchase price and mortgage debt per acre of mortgaged farm real estate in table 4.

TABLE 4.—Farm real estate purchases involving mortgage debt commitments, three county sample area, January 1, 1941 to September 30, 1943

Period	Number of purchases classified	Acres purchased	Purchase price		Mortgage debt	
			Per acre	Relative change in price per acre	Per acre	Relative change in debt per acre
			Dollars	*Per cent*	*Dollars*	*Per cent*
1941	127	12,472	67.36	100.0	44.64	100.0
1942	170	15,219	67.74	100.6	40.89	91.6
1st 9 mo. 1943	226	20,555	83.55	124.0	52.75	118.2

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

From July to October commodity prices seem to have attained some degree of stability. Farm wages are now nearly double what they were in 1940.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 = 100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	...	101	101	104	100	105	101
1914	99	...	100	101	102	102	105	109
1915	102	...	105	98	103	107	106	112
1916	125	...	124	118	113	113	121	123
1917	172	...	149	175	140	119	182	201
1918	192	...	176	202	175	131	203	243
1919	202	...	202	213	204	135	218	270
1920	225	...	201	211	236	159	212	230
1921	142	...	152	125	164	134	132	134
1922	141	...	149	132	145	124	127	133
1923	147	...	152	142	160	122	134	147
1924	143	...	152	143	165	118	133	150
1925	151	...	156	156	165	110	159	180
1926	146	...	155	145	170	105	155	183
1927	139	...	153	139	173	99	147	171
1928	141	...	155	149	169	96	154	163
1929	139	...	154	146	169	94	151	172
1930	126	...	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	140
1939	113	103	121	93	117	76	95	140
1940	114	117	122	98	116	77	99	146
1941	127	170	131	122	138	80	121	185
1942	144	227	154	157	173	89	157	244
1942								
January	140	192	146	149	153	...	141	201
February	141	199	147	145	...	...	144	183
March	142	208	150	146	...	89	146	208
April	144	210	151	150	167	...	153	230
May	144	216	152	152	...	...	157	241
June	144	222	152	151	176	...	157	232
July	144	230	152	154	179	...	159	237
August	145	233	152	163	...	...	164	248
September	145	237	153	163	...	...	161	268
October	145	249	154	169	193	...	165	290
November	146	258	155	169	...	...	167	293
December	147	267	156	178	...	...	169	297
1943								
January	149	268	158	182	196	...	174	283
February	149	275	160	178	...	...	177	261
March	150	282	161	182	...	97	181	287
April	151	284	162	185	212	...	190	296
May	152	289	163	187	...	...	197	318
June	151	293	164	190	221	...	193	318
July	150	291	165	188	229	...	192	320
August	150	...	165	193	...	...	198	333
September	150	...	165	193	...	...	193	318
October	150	...	166	192	228	...	193	...

*SOURCE: Bureau of Business Research, The Ohio State University.

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*Military Leave.
[1]In Cooperation with the U. S. Department of Agriculture.


BIMONTHLY BULLETIN
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"INVASION"
IN OHIO 1944
Are YOU Ready?
EXPERIME

YOUR FRIENDS THE AUTHORS

Paton

R. R. Paton is an associate in the Department of Forestry. He is in charge of the operation of the forest tree nurseries and also of the distribution of planting stock to co-operators. Recently he has completed a survey of all plantations of trees made with stock produced in state nurseries from 1904-1938. A report of this survey is reported in this issue under the title "Forest Planting in Ohio."

Dr. C. A. Lamb has long been a member of the agronomy department at the Stat He now holds the position of Associate in Field Crops and is in charge of the breeding work with small grains.

Lamb Lewis

Dr. R. D. Lewis is also an Associate in the Station's agronomy department, as well as Chairman of Ohio State's Department of Agronomy. Recently he has been helping farmers to maintain the quality and quantity of their crops in the face of material and labor shortages. These two agronomists, with D. F. Beard, report in this issue on the distribution of Thorne wheat in Ohio.

Lest we forget our old friends in meeting the new ones, some pictures are taken from our old albums for you to see.

J. D. Wilson
Botany

J. S. Houser
Entomology

W. E. Krauss
Dairy

D. C. Kennard
Poultry

A. R. Mangus
Sociology

J. I. Falconer
Rural Economics

CONTENTS

THE INSECT PEST INVASION IN OHIO IN 1944

J. S. HOUSER

The "second front," the invasion of Europe, and the war in the Pacific are so much in the mind of the public at the present time that the impending invasion in Ohio by the 1944 insect horde may not receive the attention it deserves. The successes abroad by the allied armies is dependent, in some measure at least, upon the degree of success attained on the home front in the control of pest insects. Insect pests, if uncontrolled, are capable of seriously reducing many sorts of supplies that are so much needed both abroad and at home. Adequate, timely planning and the proper execution of available practical control measures will do much to avoid this waste which, if unchecked, will certainly amount to several millions of dollars.

Every man, woman, and child is affected in one way or another by the harm done by insect pests, but it is the producer of commodities which are subject to insect damage who suffers most and upon whom the responsibility for control efforts lies. By "producer" I mean all the way from the "victory gardener", with his few square feet of soil, to the stockman, fruit grower, commercial gardener, and general farmer who may operate several hundred acres of land.

Whether 1944 will be a "bad bug year" remains to be seen. No one can forecast with certainty just how bad it will be, but we know with equal certainty that there will be plenty. Why? Because, much as we dislike to admit it, the aggregate damage from insect pests is increasing gradually as time goes on.

This is to be a white grub year. Last year May beetles, which lay the eggs which in turn hatch into tiny white grubs, were plentiful. Lawns and grasslands are the favorite situations in which the eggs are laid. Partly grown grubs are abundant in sod-lands this winter; therefore, those who attempt to grow corn or potatoes, as well as some other crops, on land that is in sod at the present time may expect damage from white grubs. Insofar as possible, sod-land should not be used for a vegetable garden nor for a potato field. Stockmen who depend on summer pastures will do well to remember that white grubs are likely to damage pasture-lands seriously every third year and that this is the year in the 3-year cycle when the most damage is expected.

Last fall the Mexican bean beetle increased to enormous numbers in some parts of Ohio late in the season, which means that there is a heavy overwintering population of the adult beetles. How the beetles will fare during the winter months cannot be determined at this time, but the chances are that more damage to beans will occur early in the coming season than occurred last summer. If the Mexican bean beetle is to be controlled successfully one must be prepared to act promptly as soon as the beetles appear.

PREPAREDNESS ESSENTIAL TO SUCCESSFUL PEST CONTROL

What has been said about the necessity for prompt action in Mexican bean beetle control holds equally well for all insect pests. Prompt action is dependent upon preparedness. The beginning of preparedness is to learn at least a little about insect pests in general and something more specific about the particular insects with which trouble has been experienced in the past, or with which future difficulty is anticipated.

Information on insect control is available from many sources; as, for example, the Agricultural Experiment Station at Wooster, the Extension Service of the State University at Columbus, and the United States Department of Agriculture, Washington, D. C. Locally, the office of the County Agricultural Agent is a fine source of supply for information. Many local seedsmen are well informed in matters of this sort and frequently have at their disposal for distribution the advertising literature of insecticide manufacturers which, in the main, is dependable.

It cannot be emphasized too strongly that a simple working knowledge of the habits and characteristics of the insect itself is essential if one is to succeed with the minimum amount of effort and expense in control procedures. To acquire this knowledge is not at all difficult if advantage is taken of the sources of information so easily available at this time. The person who is informed in matters of insect control is able to answer the following questions. What to use—when to use it—how to use it?

IS YOUR SPRAYER OR DUSTER IN WORKING ORDER?

Machines for applying insecticides become worn from use and all too frequently they become corroded and inoperative through lack of proper care. Now would be a good time to put the machine intended for use this season in first-class working order. If a new machine is needed it should be purchased well in advance of the season.

There is some evidence that the supply of spraying and dusting devices may be somewhat more readily available this year than last; nevertheless one should not wait until the last moment before ordering. There may be delays in manufacture, as well as in transportation.

Doubtless there will be some shortages in spraying and dusting equipment, and replacement may not be possible in all cases; therefore, it is essential that the best of care be given the machines on hand. If a duster is being used and the hopper is partly full after the job is finished, the remaining dust should be removed to a container which can be closed tightly. In most instances, if there is a remnant of liquid spray, it should be discarded because many liquid sprays are likely to deteriorate upon standing after they are diluted for use. A few minutes spent in cleaning the duster or the sprayer *after each operation* will insure continued good performance and much longer life.

BUY INSECTICIDES EARLY

What has been said about early provision for dusting and spraying equipment applies with equal force to the materials needed for spraying or dusting.

Present indications are that reasonable supplies of the more important insecticides will be available for the 1944 season, with the exception of those materials of which pyrethrum and rotenone are principal components. Some rotenone can be had for civilian use, but pyrethrum will be scarce indeed.

The advantage in purchasing supplies early is the insurance that materials will be available when needed; also congestion in shipping will be avoided during the height of the growing season.

It is particularly important that a careful estimate be made of the season's insecticide requirements in order to avoid the purchase of excessive supplies. This may be placed on a very personal basis, because if one person purchases excessively some other person may be unable to purchase any at all.

Insecticide supplies carried over from last year should not be discarded, in all likelihood they are satisfactory for use this season. This suggestion applies particularly to such scarce materials as pyrethrum and rotenone, especially if they have been stored in closed containers.

TIMELINESS AND THOROUGHNESS OF APPLICATION

Frequent, careful inspection is necessary if insect invasions are to be detected at their beginning. For example, bean beetles may appear in a few spots only in the planting and if not controlled these spots may serve as foci for a general infestation. Rose bugs may descend on grapes and may do extensive damage by destroying the entire crop while the fruit is in the blossom or even in the bud stage.

If taken in time, outbreaks of many insects may be controlled with comparatively little effort and the damage may be almost wholly prevented. If neglected, even for a few days, the consequences may be serious.

If an insecticide is to be applied, a half-way job will do little good. Thoroughness of application is essential to success.

In mixing an insecticide for use, the formula prescribed should be followed carefully and all ingredients should be weighed or measured as the case may be. Guesswork may result in failure to control or in damage to the plants—damage even in excess of what the insects might have caused. "If a little is a good thing, more will be better" does not apply at all when preparing spray or dust materials for use. It is a dangerous rule to follow.

WHAT THE EXPERIMENT STATION CAN DO

For many years the entomologists at the Ohio Agricultural Experiment Station have been working to devise ways and means for the control of the principal insect pests of Ohio. During that time many control measures have been developed which will be made available upon request to persons who are in need of them. Pest insects will be identified. Submit a good, well-packed sample, accompanied by a statement of the character of the damage and give the name of the host if a plant is involved.

The destructive effects of "Invasion in Ohio in 1944" may be very much reduced by proper preparation and by vigorous effort on the part of those who must contend with insect control problems. Are you ready?

FOREST PLANTING IN OHIO

R. R. PATON

Forest planting stock was first distributed to landowners by the State in 1904, when the Wooster Nursery at the Ohio Agricultural Experiment Station was established. Early efforts were largely concerned with the production of species suitable for fence posts, rather than for reforestation as it is thought of today. There was a great demand for catalpa, black locust, Osageorange, and mulberry.

The concept of reforestation was undergoing a fundamental change around 1920, and this was reflected in the type of planting practiced. The evergreen species, chiefly the pines, became more popular and were used in increasing numbers.

Federal assistance was made possible by the passage of the Clarke-McNary Law in 1924, and a new and larger nursery was established at Marietta in 1925. The organization of the Civilian Conservation Corps and the Soil Conservation Service in 1933 and 1935, respectively, did much to stimulate further public interest in this work, and the number of trees planted per year averaged over 2,000,000.

TABLE 1.—Shipments of planting stock by 5-year intervals

Year	Conifers	Hardwoods	Total
1904-1908	5,545	629,100	634,645
1909-1913	123,893	633,414	757,307
1914-1918	215,173	111,952	327,125
1919-1923	153,588	335,720	489,308
1924-1928	4,788,612	1,880,517	6,669,129
1929-1933	9,008,272	1,793,858	10,802,130
1934-1938	6,380,095	2,856,638	9,236,733
Grand Total	20,675,178	8,241,199	28,916,377

A great deal of this planting was done on private land by the landowners themselves, most of whom were farmers. Municipalities, institutions, and mining companies have carried on large-scale projects with good success, and in northeastern Ohio (and to a lesser extent in southwestern Ohio) there have been many fine plantings made by people living in cities, but owning extensive areas in the country.

A survey of all plantings in Ohio which had been planted with trees from the State nurseries up to and including 1938 was carried on during 1939-1941 under the supervision of the Division of Forestry. Data were collected on the location and area of the planting, site conditions, both at the time of planting and at the time of the survey, and growth and survival of the trees planted. Notes were made on any injurious agencies that were observed, and data were collected on the number and species of volunteer seedlings found in the area.

This survey was conducted for the purpose of determining what species are best adapted to the planting sites in the different parts of Ohio; what the best methods are for establishing a planting; what limitations must be met; and what some of the most common mistakes have been. This article will present a brief summary of the results. Further information may be obtained from Bulletin 647, "Ohio Forest Plantings," of the Ohio Agricultural Experiment Station, Wooster, Ohio.

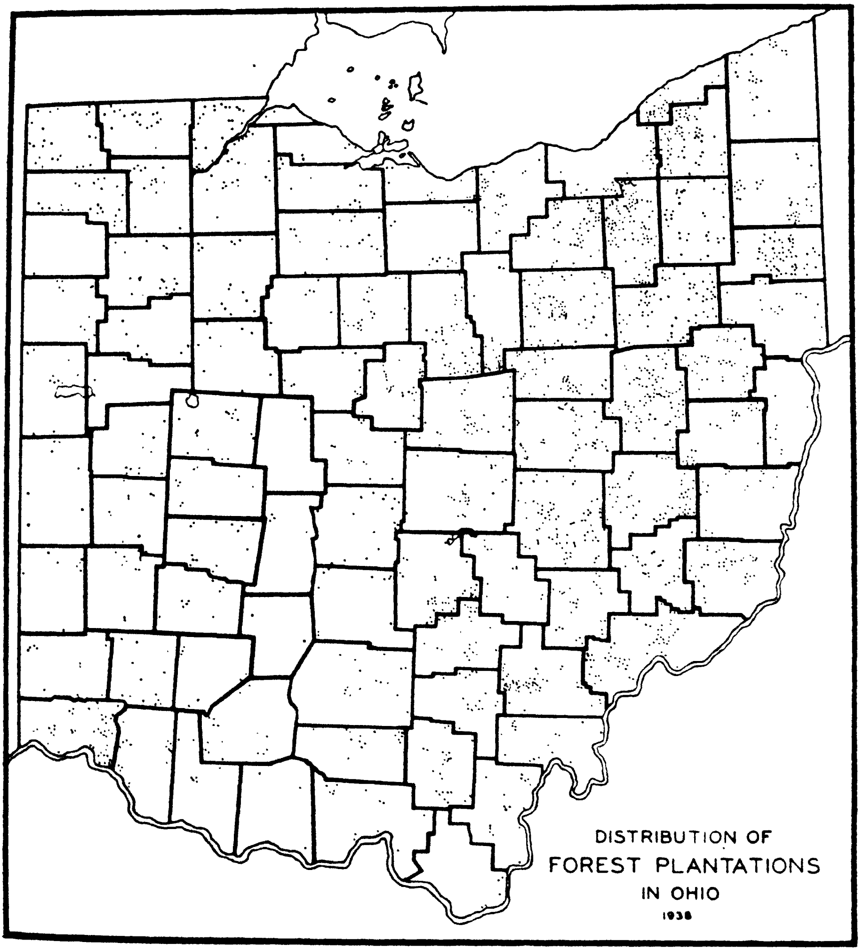

Fig. 1.—Each dot represents a successful forest planting

RECOMMENDED SPECIES TO PLANT

The species which have had the best success are the following:

White pine	Black locust
Red pine	Tuliptree
Shortleaf pine	Black walnut
Catalpa	

There are other species which have been successful and have a place in the planting program, although in a smaller way and under limitations. They are as follows:

Scotch pine	White ash
Norway spruce	Red oak
Austrian pine	Hard maple
Hemlock	Osageorange

The different species named above vary in their requirements, based on survey findings, and a brief summary of these requirements follows. It should be pointed out that research work in forest planting is continuing, and new facts are constantly being learned. It is probable that in the future more will be known regarding this work and some of the recommendations being made today may be changed. This has been true in the past. In addition, new conditions, such as insects or diseases not heard of today, may warrant change in species or methods of use. Conversely, new methods of pest control may make possible use of species which are now difficult to grow.

White pine and red pine are the species best suited for well-drained sites where fertility is low. These are satisfactory for planting throughout Ohio, excepting on heavy, wet soils or in competition with native hardwoods. Neither of these should be planted in wooded areas, even in openings as large as an acre in extent.

The best method of planting these species appears to be in furrows, plowed either on the contour or, where the site is level to gently rolling, in a north and south direction, so as to be at right angles to the prevailing winds. The furrows should be spaced 7 or 8 feet apart and the trees spaced about the same distance apart in the furrows.

If a mixture is made, and this is recommended, the best manner appears to be to plant 3 rows of one species, then 3 rows of the other, rather than a single row of each.[1]

Shortleaf pine is a rapid growing species, well-suited to southern Ohio conditions but is not recommended for points north of Columbus, or perhaps Mt. Vernon. Plowing furrows did not appear to be necessary or especially beneficial with this species. The vegetation on the site at the time of planting should not be overtopping and brush or trees were a detriment at all times.

The best exposures seemed to be south or southeast, and hilly sites were somewhat better than bottomland.

Black locust is a species which grows rapidly and is well adapted to sites which are eroding rapidly. The best growth is made on fertile land, although it will grow fairly well on poor soils. However, on such sites it is commonly attacked by the locust borer. This usually does not kill the tree but makes it of low value for fence-post production. An effort is being made to produce black locusts which are borer-resistant.

[1]Some exceptions may be necessary, as in the case of black walnut, where one row of walnut and 2 or 3 rows of the alternate species seem to be the best mixture.

The best growth and survival were found on bare sites or where the tract had been plowed.[2] Southern exposures were better than northern and hillsides better than bottomlands.

Tuliptree, or yellowpoplar, has not been planted as generally as the pines or locust, but the plantings observed indicate that it may become one of the most promising of all species. Its growth rate is usually as good as any species and frequently on the moister, more fertile areas it is the most rapid. The form is ordinarily straight and the tree, which is native to Ohio, reaches a large size at maturity.

The best conditions for this species are moderately moist hillsides or coves, north or east exposures, and furrow planting.

Black walnut will grow on hilltops and hillsides if fertility is moderately good, although the best growth is found in bottomlands. Either seedlings or nuts which have been stored over winter between layers of damp sawdust may be used successfully. The latter has many advantages over the former, however, and should be used if squirrels are not too great an obstacle.

Walnuts more than any other species should be planted in mixture, using black locust, sugar maple, red oak, or possibly tuliptrees as the associated species.

Hardy catalpa is a species having a great deal of merit for post production for the western part of Ohio; this will make good growth on fertile, moderately moist sites. Experiments at Wooster indicate that catalpa posts may last 20 years or longer. There is some evidence to indicate that the slower growing trees produce the best posts. For this reason, the trees should not be planted on fertile bottomlands and should be spaced about 5 feet apart until crowding has begun. One of the mistakes in the past that has tended to discredit this species was the planting of the southern catalpa rather than the hardy catalpa. Many plantings were also made on sites ill-suited to the species.

The other species named on page 88 all have merit for particular situations. These will be discussed briefly.

The Scotch pine is well adapted for windbreak plantings in western Ohio, as is the Norway spruce. Neither of these species is suitable for forest plantings in eastern Ohio, the former because of insect enemies, the latter because of its relatively slow growth on the average, old-field site. The spruce also requires either mowing or cultivation in its early years.

The Austrian pine is better suited to heavy soils than the other pines. It is seriously attacked by field mice, however, and these frequently destroy a planting completely.

The hemlock is the only species of evergreen which will grow under the shade of our native hardwoods. The best site for hemlock is on a cool, moderately moist, north or east exposure on soil with leaf mold present.

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[2]Plowing, for other species as well as locust, normally consists of single furrows spaced about 7 feet apart, rather than the entire area being plowed. The single furrows are better than complete plowing. A still better method, developed by H. P. Garritt of the Soil Conservation Service, is as follows:

A furrow is plowed on the contour, throwing the sod up the hill. Then returning, this sod is thrown down the hill into the first furrow by plowing a new furrow directly under the first freshly turned slice. This results in a well-mixed ridge of earth and sod filling the first furrow, and with the new furrow on the uphill side. If this plowing can be done the fall previous to planting, frost action will further mellow the sod-soil mixture and make for ideal planting. The trees are planted in the upper face of the ridge about midway between the furrow bottom and the top of the ridge. A dam of loose earth should be pulled into the furrow near the tree.

White ash apparently makes the best growth on moderately dry sites, preferably on fertile soil where leaf mold is present—that is, under a light shade of older hardwoods.

Red oak is well suited to moderately fertile areas or in mixture with native trees. Rabbits select this species, however, for winter feeding and where they are numerous, the red oak may be destroyed. Some control measures may be found which will solve this problem.

Osageorange produces the most durable posts grown in Ohio and is a satisfactory tree to plant on moderately moist, fertile sites. Considerable pruning in early years is essential to produce single stems.

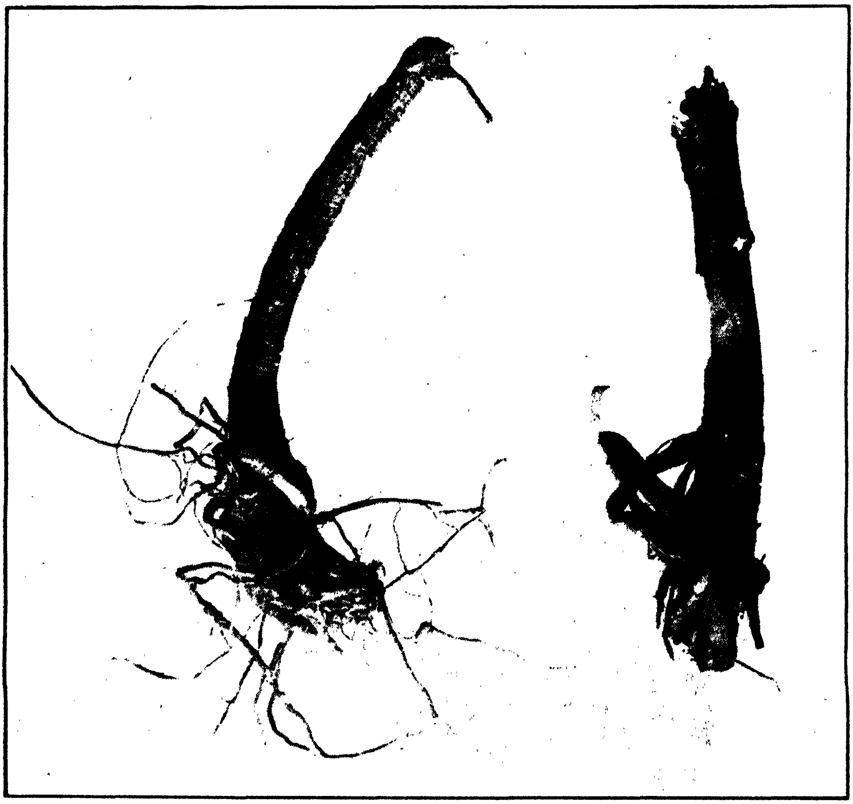

Fig. 2.—Roots of two red pines, cramped at the time of planting, never recovered, resulting in the death of the trees several years later

Careful planting is an important part of a reforestation project; lack of this was found to be one of the chief causes for failure. Good planting includes planting as early in the spring as possible, removing the trees from the shipping container immediately upon arrival, heeling-in the trees until planting can be done, carrying the trees in a pail with water over the roots during the planting process, digging a hole deep enough to accommodate the roots without crowding (see figure 2), and pressing the earth firmly over the roots.

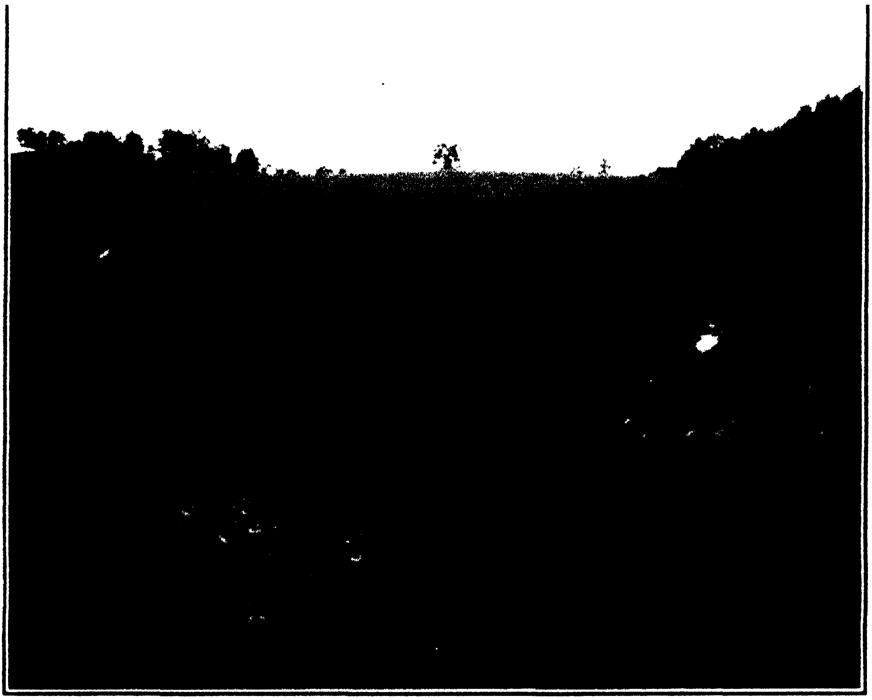

Fig. 3.—A good example of the type of area where pines should not be planted. This field was planted with pines, the native species soon choked them all out

Many failures were due to leaving the trees in the package too long, in some cases for as long as 2 months, and many were due to careless handling so as to allow the roots to dry out.

Another common mistake was the planting of pines and spruces in native woods for the purpose of restocking thin areas. Such plantings are nearly always failures or virtually so. For such plantings, tuliptrees, white ash, hard maple, red oak, or black walnut should be used, or, if an evergreen is desired, the hemlock (figure 3).

Pasturing of plantations is a mistake, but fortunately only 5 per cent of the plantings visited were being grazed. Livestock seriously injure the young trees and eventually will destroy a planting and even a woods, if heavily grazed.

Control of the competing vegetation in a planting proved to be necessary in some instances, but the plowing of furrows or, if this was impractical, scalping of an area 1½-2 feet square around each tree at the time of planting usually appeared to be sufficient. The use of 4- or 5-year transplants of evergreens (excepting shortleaf pine) may be necessary if competing growth is heavy. Shortleaf pine normally reaches adequate size in 2 years.

One- or 2-year-old stock of the deciduous trees is usually large enough for the average planting site, the latter being preferable if available.

The Division of Forestry has two forest nurseries, at Marietta and Wooster, where stock is grown for distribution to landowners for reforestation purposes at a nominal price. These trees are solely for forest planting—that is, the restocking of land which should be returned to forest permanently. In view of this, the planting of small groups or single or even double rows is not permitted as such plantings cannot be classified as forests. The planting of land of high value or of that within corporation limits is also of doubtful wisdom.

Application blanks for trees may be secured by writing to the State Forester, Ohio Agricultural Experiment Station, Wooster, Ohio.

THORNE WHEAT HAS SPREAD RAPIDLY IN OHIO

C. A. LAMB, R. D. LEWIS, AND D. F. BEARD

Thorne wheat was first distributed to certified seed growers by the Ohio Agricultural Experiment Station in 1937. The variety proved well adapted to most sections of the State and spread rapidly. It is of interest to note how much of the Ohio wheat acreage is now occupied by Thorne wheat.

Previous to the introduction of Thorne, almost all varieties of wheat grown in Ohio were white chaffed, and no other red-chaffed beardless wheat is being grown on any appreciable acreage. Red-chaffed Goldcoin and American Banner (white-kerneled wheats) are grown in restricted areas around Toledo in northwestern Ohio. Outside of this area, it is relatively easy to observe whether a field of wheat near maturity has white or red chaff, and it is safe to assume that practically all beardless red-chaffed fields are Thorne. Thus, in June and early July of 1943 counts were made by several persons in the course of their travels on extension, seed inspection, or research projects. As special trips were not made because of shortages of gasoline and rubber, important areas of the State could not be covered in this survey. However, fields in reasonably representative areas were counted, except in the northwestern part of the State.

Intensive coverage was made in travel by several routes between Wooster and Columbus. Counts were also made on two trips from Columbus to County Farms in the southwest part of the State and on one trip from Columbus to the Miami County Farm. The remaining data were collected on trips made during inspection of fields of small grains by Seed Improvement Association inspectors. The table summarizes the actual counts made, by trips, insofar as they were identified as to counties by the observers. Care was taken that the same stretch of road was not recorded twice; when counties appear in several trips, new highways are involved each time.

TABLE 1.—Counts of red-chaffed, white-chaffed, and bearded wheats in Ohio on automobile trips in 1943

Trip No.	Counties in count on various trips	Total fields	Number of fields			Per cent of fields		
			Red chaff	White chaff	Bearded	Red chaff	White chaff	Bearded
1	Central Ohio:							
	Franklin	21	12	4	5	57	19	24
	Pickaway	41	17	17	7	42	42	17
	Ross	28	10	13	5	36	46	18
	Fayette	28	21	6	1	75	21	4
	Green	40	26	13	1	65	33	3
	Union	21	11	6	4	52	29	19
	Marion	19	11	5	3	58	26	16
	Hardin	33	16	11	6	49	33	18
2	Central northeast Ohio:							
	Franklin, Delaware, Licking, Knox, Wayne, Holmes	241	198	42	1	82	17	......
3	Central southwest Ohio:							
	Franklin, Madison	59	27	19	13	46	32	22
	Clark	24	9	10	5	38	42	21
	Miami	26	14	10	2	54	38	8
	Champaign	36	15	9	12	42	25	33
	Franklin, Licking	22	8	14	0	36	64	0
4	Southwestern Ohio:							
	Butler	37	20	10	7	54	27	19
	Montgomery, Darke	94	49	45	0	52	48	0
	Darke, Miami	66	22	36	8	33	55	12
5	Northeastern Ohio:							
	Wayne	55	46	9	0	84	16	0
	Ashland, Knox	57	37	20	0	65	35	0
	Knox, Delaware	5	3	2	0	60	40	0
	Delaware, Franklin	13	10	3	0	77	23	0
	Franklin, Delaware	25	15	7	3	60	28	12
	Delaware, Richland	70	51	19	0	73	27	0
	Richland, Ashland, Wayne	96	78	18	0	81	19	0
6	Northeastern to southwestern Ohio:							
	Richland, Crawford, Morrow, Delaware, Franklin	104	78	26	0	75	25	0
	Franklin, Pickaway, Fayette, Clinton	121	68	38	15	56	31	12
	Clinton, Brown, Clermont	34	19	13	2	56	38	6
	Clermont, Hamilton	24	17	7	0	71	29	0
	Montgomery, Greene	47	37	10	0	79	21	0
	Greene, Clark, Madison	48	27	18	3	56	38	6
	Madison, Union, Delaware	73	43	16	14	59	22	19
	Delaware, Morrow, Knox, Richland, Ashland, Wayne	284	248	36	0	87	13	0
	Grand totals	1,892	1,263	512	117	67	27	6

It will be noted that the distributions of Thorne (counting beardless red-chaffed fields as Thorne) and of the bearded wheats are not uniform. There is an area in Champaign, Clark, Union, Madison, and Fayette Counties, where bearded wheats still occupy considerable acreages. Baldwin (a synonym for Goens) is the most common bearded variety in this area. In Darke and Miami Counties there are neighborhoods where Nigger, another old bearded variety, is still widely grown.

In Wayne County, Thorne has replaced other varieties in a very high percentage of fields—probably above 95 per cent. Traveling southwest toward Columbus, the number of white-chaffed fields gradually increases. Bearded wheats are rare north of a line through Union and Delaware Counties.

In the opinion of Extension Agronomists and others who travel over the State, the Thorne variety is more widely grown in northwestern than in southwestern Ohio. Scab injury has been more severe in the south and has kept the acreage down. The very severe injury from this disease in 1943 may very well result in a decrease in Thorne acreage for the southwestern area.

The last count reported in the table includes a large number of small fields in the hilly territory between Butler (Richland County) and Wooster. A very high percentage of Thorne wheat is grown in this area, weighting the grand totals in favor of Thorne because the total acreage is less than for the same number of fields in other parts of the State. However, since the percentage in the northwest would likely be higher than that of the southwest, the general average figure of 67 per cent for Thorne is probably not far from the actual situation. It certainly is conservative to state that more than half the wheat acreage of Ohio in 1943 was of the Thorne variety.

Thorne wheat has enjoyed a remarkable expansion in acreage since its introduction in 1937. In September of 1937 the total supply of seed was 70 bushels. This was multiplied by five growers chosen from among the experienced members of the Ohio Seed Improvement Association and in two other small fields, one at the Experiment Station at Wooster and the other at Northwest Test Farm at Holgate. The seed from the 40 acres harvested in 1938 was distributed to growers who agreed to produce certified seed and who further agreed not to market their crop for seed if it failed to meet certification standards. A very high percentage of the 765 acres harvested in 1939 was certified, and a good supply of seed became available for the first time. Insofar as it was possible to check, it appears that practically all the 1940 and much of the 1941 crop was saved for seed. In 1939, 18,109 bushels were certified, 79,043 bushels in 1940, 81,906 bushels in 1941, 39,848 bushels in 1942, and 19,259 bushels in 1943. Of course, much of the general crop also moved from farm to farm. The peak sale of certified seed for use on Ohio farms probably was reached in 1941. Considerable quantities have been shipped to Pennsylvania and Kentucky in the last 2 years.

With propably 1,000,000 acres harvested in 1943 in Ohio and with very considerable acreages in other states, Thorne is now one of the most widely grown soft red wheat varieties in the United States. It reached this important position in 6 years from a start of 70 bushels of foundation seed planted in the fall of 1937.

THE CONTROL OF CELERY BLIGHTS WITH BORDEAUX, THE FIXED COPPERS WITH AND WITHOUT SULFUR, AND FERMATE

J. D. WILSON

Early blight of celery, caused by *Cercospora apii* Fres., occurs every year in Ohio. *Septoria apii* (Bri. and Cav.) Rostr., or late blight, may be found somewhere in the State nearly every year but it is not as common as the early form. When late blight does occur under weather conditions especially favorable for its development, it may cause a near crop failure (1). Under these conditions the disease is very difficult to control, and even frequent applications of Bordeaux mixture will not prevent a considerable crop loss, especially if the disease gets a good start on young plants before, or soon after, they are set in the field. Early blight (the symptoms of which are large tan-colored, clear, spots on the leaves, in contrast to the smaller spots of late blight that are closely packed with black dots (pycnidia) of pin-point size) is less likely to cause extremely severe defoliation than late blight. It frequently persists throughout the growing season, however, with any but the best control program.

The celery blights have been rather successfully controlled experimentally in Ohio by the use of Bordeaux mixture and copper-lime dust (1), and many of the growers now use one or the other of these materials to prevent excessive crop loss. Townsend (2) also found Bordeaux mixture to be one of the most dependable spray materials for the control of early blight in Florida, and Richardson (3) recommends it for the control of late blight in Ontario.

Early in the 1930's various fungicide manufacturers became interested in the fixed coppers as substitutes for Bordeaux mixture, and in 1934 one of the basic copper sulfates was compared with Bordeaux mixture at Willard. Since that time a considerable number of them have been compared one with another and with Bordeaux mixture for the control of the early and late blights of celery (4, 5, 6, 7, 8) in Ohio.

All of these tests were conducted on muck-grown celery with replicated plots. The number of replications varied somewhat in the earlier experiments, but in all of those listed for 1939 to 1943, inclusive, there were five replications of each treatment. The percentage of the foliage area still green or unaffected by disease was estimated with considerable care at harvest time or just

1. Wilson, J. D., and A. G. Newhall 1930. The control of celery blights. Ohio Agr. Exp. Sta. Bull. 461: 1-30.
2. Townsend, G. R. 1942. Spraying and dusting for the control of celery early blight in the Everglades. Fla. Agr. Exp. Sta. Bull. 366: 1-26.
3. Richardson, J. K. 1936. Control of late blight of celery. Sci. Agr. 16: 358-364.
4. Wilson, J. D. 1936. The value of "insoluble" coppers in vegetable disease control. Proc. Ohio Veg. Growers' Assoc. 21: 99-104.
5. Wilson, J. D. 1938. Insoluble copper compounds for spraying vegetables. Proc. Ohio Veg. Growers' Assoc. 23: 35-41.
6. Wilson, J. D. 1940. Further studies on the use of fixed copper compounds in controlling vegetable diseases. Proc. Ohio Veg. and Potato Growers' Assoc. 25: 75-86.
7. Wilson, J. D. 1941. Further studies on the use of fixed copper compounds for the control of vegetable diseases. Ohio Veg. and Potato Growers' Assoc. 26: 20-23.
8. Wilson, J. D. 1942. The fixed coppers on vegetables in 1941 with special reference to the influence of supplemental materials. Proc. Ohio Veg and Potato Growers' Assoc. 27: 61-75.

before, and these data are included in the tables that refer to the later experiments. The magnitude of the difference necessary for significance between yields has been determined by statistical methods whenever and wherever the data were of such nature that this could be done. The sprays and dusts were chiefly applied with power-driven equipment mounted on wheelbarrows, but some work was done with hand dusters and a power sprayer was used in two or three instances.

No yield data were obtained in the experiment of 1934 at Willard, but the relative amount of disease on the foliage of the differently treated plots was obtained by counting the number of petioles (stalks) that bore diseased leaflets in each 100 feet of row. These data are given in table 1. Bordeaux mixture gave the best disease control in this experiment, followed by copper-lime dust. The two fixed-copper compounds (basic copper sulfate and copper oxychloride) ranked somewhat lower. The addition of bentonite did not improve the results obtained with copper-lime dust or basic copper sulfate, in spite of its adhesive properties (9). Nelson (10) found adhesives to increase the copper deposit without having much effect on disease control, or yield, and Townsend (2) found them to have little effect on yield or blight control in Florida. The two fixed coppers gave similar results when applied as dusts and sprays.

TABLE 1.—Comparison of fixed coppers, Bordeaux mixture, and copper-lime dust on celery at Willard in 1934

Treatments	Number of stalks showing diseased leaflets per 100 feet of row
Copper-lime dust, 20-80	260
Copper-lime dust+bentonite, 20-40-40	280
Basic copper sulfate+lime+bentonite, 14-76-10	596
Basic copper sulfate+talc, 14-86	404
Copper oxychloride+talc, 30-70	458
Bordeaux mixture, 8-12-100	225
Basic copper sulfate, 4-100	425
Basic copper sulfate+lime, 4-4-100	400
Copper oxychloride, 12-100	465
No treatment	965

In 1935 several of the fixed coppers, used with and without an adhesive (Wyojel bentonite), were compared with Bordeaux mixture for the control of celery blights at Copley. The results are shown in table 2. Early and late blights were both present and both were of medium severity. All treated plots produced significantly larger yields of trimmed celery than the untreated plots, which had become severely defoliated from disease by harvest time. Bordeaux mixture gave better control of late blight (see foliage score) than any of the fixed-copper compounds, but the yield was not significantly greater in most instances. The addition of bentonite as a sticker and load builder for the fixed coppers was not justified in terms of increased yields or better disease control. The average yield resulting from the use of the fixed coppers with Wyojel was 9.49 tons per acre and the average number of blighted leaves per 100 feet of row was 267; whereas the respective averages for the plots that did not receive the adhesive were 9.46 tons and 246 diseased leaves, respectively.

9. Young, H. C., and J. R. Beckenbach. 1936. Spreader materials for insoluble copper sprays. Phytopath. 26: 450-455.

10. Nelson, R. 1939. Tests of new dust and liquid fungicides in 1938 for the control of celery leaf blights. Mich. Agr. Exp. Sta. Quar. Bull. 21: 295-307.

TABLE 2.—Control of celery blights by various fixed coppers at Copley in 1935

Treatments	Yield in tons per acre	Number of stalks showing blighted leaflets per 100 feet of row
Bordeaux mixture, 8-8-100	10.28	112
Copper Hydro, 8-100	10.04	174
Copper Hydro 40 + Wyojel, 8-8-100	10.00	179
Copper A, 4-100	9.60	166
Copper A + Wyojel, 4-8-100	9.52	182
Cuprocide + Wyojel, 2½-8-100	9.44	282
Coposil, 8-100	9.40	276
Coposil + Wyojel, 8-8-100	9.36	340
Cuprocide, 2½-100	9.28	300
Basicop + Wyojel, 4-8-100	9.16	350
Basicop, 8-100	8.92	312
No treatment	5.40	680
Difference required for significance at the 5 per cent level	1.28	....

Several fixed copper compounds were compared with Bordeaux mixture on late celery at Copley in 1937. Most of the sprays were applied with the usual hydraulic equipment but the plots in one section of the experiment were sprayed with an experimental vapor (steam) sprayer (11). The data relative to this experiment are given in table 3. Septoria (late) blight was present on the plants when they were set in the field and it became severe before harvest on the untreated plants. In the section of the experiment sprayed with the usual equipment, there was no significant difference in the yield from plots treated with the different fixed coppers or Bordeaux mixture. Super copper (an ammoniacal copper carbonate) and Palustrex "B" (emulsified copper resinate and distilled pine oil) were both inferior to the other materials in both disease control and yield. The results obtained with the 8-4-100 and 8-8-100 Bordeaux formulas were similar in both disease control and yield. Townsend reported that a low-lime formula gave excellent results in Florida (2).

The results obtained when Bordeaux and several fixed coppers were applied under the rather high temperatures (335° F.) that accompanied a steam pressure of 100 pounds were similar to those for the usual hydraulic method. Blight control was reduced slightly but most of the steam plots were in good condition at the end of the season. Bordeaux mixture was altered, in appearance at least, to a greater extent at 100 pounds of steam pressure than were most of the fixed coppers. Its appearance was more normal at 75 pounds (300° F.) and it gave considerably better disease control than at the higher temperature and pressure.

11. Hedden, O. K., and R. M. Merrill. 1940. Experiments in the use of vapor-spray equipment. U. S. Dept. Agr. Circ. 598: 1-19.

TABLE 3.—A comparison of various fixed copper compounds and Bordeaux mixture applied with hydraulic and steam sprayers to celery at Copley in 1937

Treatment	Hydraulic sprayer		Vapor sprayer*	
	Tons per acre of trimmed celery	Foliage score 1=most disease 10=least	Tons per acre of trimmed celery	Foliage score 1=most disease 8=least
Bordeaux mixture, 8-8-100	4.44	7	4.31	2
Bordeaux mixture, 8-8-100*	....	....	4.44	7
Bordeaux mixture, 8-4-100	4.06	10	....	....
Cupro-K + flour, 8-8-100	4.24	5	4.84	6
Copper A + flour, 5-8-100	4.60	6	4.27	8
Coposil + flour, 8-8-100	4.50	9	4.62	5
Copper Hydro 40 + flour, 8-8-100	4.13	8	3.74	3
Cuprocide 54 + flour, 3½-8-100	4.02	4	4.27	4
Super Copper, 1-100	3.70	3	....	....
Palustrex "B", 1-100	3.25	2	....	....
No treatment	2.74	1	2.74	1
Difference required for significance at the 5 per cent level	1.04	....	....	....

*All vapor sprays applied with steam pressure of 100 pounds except the second Bordeaux mixture listed which was applied at 75 pounds.

In 1938 a list of materials similar to that used at Copley in 1937 was applied to a late planting of celery at McGuffey. The data relative to this experiment are given in table 4. Both the early and late blights of celery were very scarce in this experiment and, interestingly enough, all treatments reduced the yield below that of the untreated check. This indicates that spraying must injure celery enough to cause a reduction in yield in the absence of disease. This injury was probably partly mechanical and partly physiological. Nelson (10) found that some of the fixed coppers caused a chlorosis (yellowing) of celery foliage in various tests conducted in Michigan. Most of the reductions in table 4 were not significant, although the plot treated with Bordeaux mixture did show a considerable loss in yield in this instance.

TABLE 4.—A comparison between several fixed coppers and Bordeaux mixture during 1938 at McGuffey when celery blight was very scarce

Treatments	Yield in tons per acre
Bordeaux mixture, 8-8-100	10.68
Bordeaux mixture, 8-4-100	11.20
Tribasic 34, 6-100	11.84
Copper A, 5-100	11.92
Cupro-K, 8-100	11.04
Cuprocide 54-Y, 4-100	11.44
Coposil, 8-100	11.40
Super Copper, 1-400	11.84
No treatment	13.48
Difference required for significance at the 5 per cent level	2.56

A number of fixed coppers were again compared with Bordeaux mixture on celery at McGuffey in 1939. The results are given in table 5. Late blight did not appear in this planting and early blight was present in only medium severity at harvest. As a result, the untreated plants produced a comparatively large crop and the yields from the treated plots were not much greater.

Only 0.75 ton per acre was required to indicate a significant difference between treatments. On this basis, all but two of the fixed coppers were better than the untreated check. Bordeaux mixture was significantly better than on the two poorest treatments. The foliage scores at harvest were similar for the five treatments that produced yields significantly better than the untreated plots.

TABLE 5.—The fixed coppers versus Bordeaux on a late planting of celery where early blight was comparatively scarce and late blight was absent (McGuffey 1939)

Treatments	Trimmed celery in tons per acre	Foliage score—Percentage of foliage free of disease at harvest
Bordeaux, 8-8-100	11.04	91
Tribasic + flour, 4-4-100	10.92	88
Copper A + flour, 4½-4-100	10.90	88
Cuprocide 54-Y + flour, 4-4-100	10.74	89
COC-S + flour, 4-4-100	10.62	86
Copper Hydro 40 + flour, 8-4-100	10.26	81
Brown cupric hydrate (BCH) + flour, 3-4-100	10.02	83
No treatment	9.60	73
Difference necessary for significance at the 5 per cent level	0.75	10.6

Fourteen fixed coppers were compared one with another and with Bordeaux mixture on a mid-season planting of celery at Willard in 1939. The data relative to this experiment are given in table 6. Late blight was scarce in this planting but early blight appeared in the seedbed and persisted throughout the growth of the crop. The untreated plots were severely diseased at harvest with only 28 per cent of the rather sparse foliage still free of disease. The foliage condition did not differ widely for the six fixed coppers that ranked highest in yield in this experiment. Bordeaux mixture again gave the best control of early blight infection, and the yield from this treatment was significantly better than that from all but two of the fixed coppers. On the other hand, all but one of the fixed-copper plots were significantly better than the untreated checks. Foliage condition at harvest was not a criterion of yield in every instance but, in general, good disease control was accompanied by good yields.

TABLE 6.—Fourteen fixed coppers and Bordeaux on celery at Willard in 1939 when early blight persisted throughout the growth of the crop

Treatments	Trimmed celery in tons per acre	Foliage score—Percentage of foliage free of disease at harvest
Copper oxalate + flour, 10-4-100	10.86	80
Bordeaux mixture, 8-8-100	10.62	88
Cuprocide 54-Y, 4-100	9.66	76
Copper oxychloride (H) + flour, 4-4-100	9.12	80
COC-S + flour, 4-4-100	9.00	77
Cuprocide 54, 4-100	8.88	68
Copper A + flour, 4½-4-100	8.34	79
Spraycop + flour, 6-4-100	8.22	62
Copper Hydro 40 + flour, 8-4-100	8.10	68
Brown cupric hydrate (BCH) + flour, 2⅔-4-100	7.80	50
Coposil + flour, 8-4-100	7.62	66
Tribasic + flour, 4-4-100	7.32	69
Cupro-K + flour, 8-4-100	7.20	48
Basicop + flour, 4-4-100	6.30	47
Basic copper arsenate + flour, 4⅔-4-100	5.04	41
No treatment	4.86	28
Difference required for significance at the 5 per cent level	1.36	12.2

Seven of the fixed coppers listed in the preceding experiment were compared as dusts with copper-lime dust in a series of plots adjacent to the sprayed ones of table 6. The data representing these dusted plots are given in table 7. All cultural, environmental, and disease conditions were similar in the two series of plots. Flour, which was used as an adhesive in the spray formulas, was replaced by bentonite in the dust treatments. Four of the fixed-copper compounds were not significantly different from copper-lime dust but three of them were poorer. The fixed-copper compounds as a group occupied much the same relative positions in disease control and plot yield when used as dusts and sprays, with Cupro-K and Brown Cupric Hydrate at the bottom of both lists of eight materials. All treatments gave significant yield increases over no treatment. The average foliage condition for the sprayed and dusted plots was very similar, but the average yield of the dusted plots was 1 ton per acre more than that of the sprayed plots. The average foliage conditions for the two types of application were approximately equal.

TABLE 7.—Comparative yields and disease control obtained when seven fixed copper compounds and copper-lime dust were applied as dusts to a mid-season planting of celery at Willard in 1939. Early blight infection was severe by harvest

Treatments	Trimmed celery in tons per acre	Foliage score—Percentage of foliage free of disease at harvest
Copper oxychloride (H)+bentonite+talc, 12-20-68	11.88	82
Copper-lime, 20-80	11.10	79
Copper A+bentonite+talc, 13-20-67	10.74	77
COC-S+bentonite+talc, 12-20-68	10.44	80
Tribasic+bentonite+talc, 12-20-68	9.42	64
Cuprocide GA+bentonite+talc, 7-20-73	8.94	73
Cupro-K+bentonite+talc, 24-20-56	7.74	46
Brown cupric hydrate (BCH)+bentonite+talc, 8-20-72	7.26	53
No treatment	4.86	26
Difference required for significance at 5 per cent level	1.45	11.4
Average for all 8 dusts	9.69	69
Average for same 8 sprays	8.63	70

Three fixed coppers were compared with Bordeaux mixture that was applied at two different spray intervals at McGuffey in 1940. The tests were duplicated on an early and a late crop of celery and the data are given in tables 8 and 9, respectively. Both early and late blight became rather severe in the early planting by harvest time (table 8), as is indicated by a foliage score of 40 for the untreated plots. All treated plots yielded significantly more than the untreated checks. Bordeaux at the 4-day interval was definitely better in yield and disease control than that at the 8-day interval in this experiment. The percentage of trim (diseased stalks and leaflets that had to be removed from each plant in preparing it for market) was similar for the two spray intervals. Tribasic scored lower in disease control than Bordeaux mixture and Copper A but trimmed away somewhat less. The untreated plots showed a higher percentage of trim than any of the treated plots, as would be expected from an examination of the comparative foliage scores.

TABLE 8.—Fixed coppers and Bordeaux on an early planting of celery at McGuffey in 1940. Early and late blight were comparatively severe

Treatments	Interval (days) between sprays	Yield in tons per acre		Percentage of trim	Percentage of foliage free of disease at harvest
		Untrimmed	Trimmed		
Copper A+flour, 4-6-100	8	24.85	12.43	50.0	82
Bordeaux mixture, 8-8-100	4	23.10	11.83	48.8	86
COC-S+flour, 4-6-100	8	21.63	11.73	45.8	74
Bordeaux mixture, 8-8-100	8	20.12	10.47	48.0	78
Tribasic+flour, 4-6-100	8	19.18	10.15	47.1	66
No treatment	....	12.75	5.95	53.3	40
Difference required for significance at the 5 per cent level	.....	....	1.25	....	11.4

Early blight was scarce in the late planting (table 9) but late blight was quite severe during the latter half of the growing period for this crop. The amount of disease present on the foliage at harvest was similar on the two plantings but the yields were somewhat lower for the late crop. The percentages of trim were slightly less also. All treatments were significantly better than the check plots in yield. Bordeaux applied at the 4-day interval was again better than at 8 days, and the difference corresponded exactly to that required for significance. When applied at the same interval (8 days), Bordeaux was not significantly better than Copper A and COC-S but did exceed Tribasic in yield and disease control. The plots treated with Bordeaux mixture trimmed somewhat less than those that received the fixed coppers, and the untreated plants were again highest in this respect. There was little evidence of foliage injury or stunting of the plants with 4-day applications of Bordeaux mixture in these experiments conducted during a season of comparatively plentiful soil-moisture supply, but this type of injury did appear in a similar test the following year (see table 10), and Townsend (2) observed injury in Florida when Bordeaux was applied too frequently or too heavily.

TABLE 9.—Bordeaux at two timing intervals and three fixed coppers on a late planting of celery at McGuffey in 1940. Late blight was of medium severity

Treatments	Interval (days) between sprays	Yield in tons per acre		Percentage of trim	Percentage of foliage free of disease at harvest
		Untrimmed	Trimmed		
Bordeaux mixture, 8-8-100	4	19.12	11.07	42.1	90
Bordeaux mixture, 8-8-100	8	17.58	9.93	43.5	82
COC-S+flour, 4-6-100	8	17.41	9.23	47.0	80
Copper A+flour, 4-6-100	8	16.30	9.06	44.4	76
Tribasic+flour, 4-6-100	8	15.18	8.00	47.3	65
No treatment	....	13.42	6.43	52.1	42
Difference required for significance at the 5 per cent level	....	....	1.14	....	11.9

Bordeaux mixture and COC-S were applied to a midseason planting of celery at McGuffey in 1941. Three timing intervals between sprays were used for these two materials. A considerable number of formulas that included other copper compounds and various supplemental materials were applied at the intermediate interval of 6 days. The results are given in table 10. The celery in this planting was Epicure and a large crop of good quality was produced. Even the untreated check plots did better than usual, although early

blight was of medium severity at harvest. Late blight was scarce throughout the season. Yield difference between the treated plots was significant in only a few instances and the degree of disease control obtained with the different materials did not differ greatly. All treated plots produced a significantly larger yield than the untreated checks.

TABLE 10.—Bordeaux mixture and COC-S at three timing intervals and the use of various supplemental materials with COC-S on mid-season celery at McGuffey in 1941. Early blight was of medium severity at harvest

Treatments*	Interval (days) between applications	Yield in tons per acre of trimmed celery	Foliage score—Percentage of foliage free of disease at harvest
Bordeaux mixture, 8-8-100	4	17.43	82
Bordeaux mixture, 8-8-100	6	18.54	80
Bordeaux mixture, 8-8-100	8	17.22	76
COC-S+flour, 4-4-100	4	17.98	80
COC-S+flour, 4-4-100	6	19.29	78
COC-S+flour, 4-4-100	8	18.36	76
COC-S+R-54 sticker, 4-1/4-100	6	17.31	80
COC-S+flour+Cal Zinc, 4-4-2-100	6	18.12	74
COC-S+Kolofog, 4-2-100	6	18.69	74
COC-S+bentonite, 4-4-100	6	17.28	76
COC-S+bentonite+E M 23 talc, 13-13-74	6	18.38	82
COC-S+bentonite+Pyrax ABB, 13-13-74	6	18.36	78
Tribasic+flour, 4-4-100	6	18.75	78
Copper oxychloride (R), 4-4-100	6	17.64	80
Cuprocide, 2½-4-100	6	16.59	76
No treatment	....	14.58	46
Difference required for significance at the 5 per cent level	....	1.61	10.4

Both Bordeaux and COC-S gave their best results in terms of yield when used at the 6-day interval. Disease control was somewhat better at the 4-day interval in each instance and poorest at 8 days. Better disease control was apparently offest by spray injury at the 4-day interval, with no increase in yield over the 6-day period; whereas at 8 days the lessened disease control was reflected in a decreased yield below that obtained with the 6-day interval (2). None of these yield differences were statistically significant, however. Bentonite was similar to flour as an adhesive. The addition of Kolofog (a sulfur bonded with bentonite) to COC-S did not improve either yield or disease control and the use of Cal Zinc was equally ineffective. Townsend (2), working in Florida, found the addition of zinc sulfate to Bordeaux did not improve disease control. Dusts were comparable to sprays in disease control. EM 23 and Pyrax ABB performed similarly as diluents in dust mixtures. Three other fixed-copper compounds were not significantly different from COC-S in disease control.

A late planting of Utah celery was dusted with mixtures of sulfur with three different fixed coppers. Early blight appeared on the plants soon after they were transplanted and persisted until harvest. It became severe on the untreated checks before the end of the season causing a considerable reduction in yield and quality (see table 11). All treated plots yielded significantly more than the checks and the improvement in foliage score was also significant. The addition of sulfur to COC-S gave an increase in yield over COC-S

used without it that was just barely significant, but the increase in disease control, as indicated by an improvement in the foliage score, was significant. The results obtained with the three fixed coppers used were very similar. Nelson, (11) recommends a Cuprocide-sulfur-talc mixture for the control of celery blights in Michigan.

TABLE 11.—Influence of sulfur on control of early blight in a late planting of celery at McGuffey in 1941

Treatments	Yield in tons per acre of trimmed celery	Foliage score—Percentage of foliage free of disease at harvest
Cuprocide + sulfur + Pyrax, 8-30-62	12.06	76
Tribasic + sulfur + Pyrax, 14-30-56	12.48	75
COC-S + sulfur + Pyrax, 14-30-56	12.24	72
COC-S + Pyrax, 14-86	11.37	60
No treatment	8.76	40
Difference required for significance at the 5 per cent level	0.79	8.4

A rather extensive planting of Epicure celery at McGuffey in 1942 was treated with a considerable variety of dust formulas in which the fungicidal agent and the diluent were varied. Sulfur was included in many of the dust mixtures and its content was varied. The data are given in table 12. Growth was excellent in most of the treated plots and a large yield of high-quality celery was the result. Early blight appeared in the latter half of the growth period and became severe enough by harvest to reduce definitely the yield and quality of the untreated check plots. The percentage of trim values are relatively much the same as those representing the foliage scores but they do differ in some instances. As a rule, those plots that had been most severely attacked by disease (early blight) trimmed the heaviest, but this was not always the case. For instance, the first treatment listed gave a lower percentage of trim, with a foliage score of 64, than did many of the other treatments that gave better disease control.

In general, it can be said that the addition of sulfur to the fixed copper formulas improved yield and disease control, although the increase in yield was significant only for Tribasic. The improvement in foliage condition was definite for COC-S, Cuprocide, and Tribasic. The average percentage of trim was the same for four fixed coppers with and without sulfur. The average increase in yield was 0.8 ton per acre of trimmed celery when sulfur was added, and its use improved the foliage score by 9.5 per cent. When used with COC-S, 20 per cent of sulfur in the formula was comparable to 30 per cent. The substitution of an acid clay diluent for an alkaline talc made little difference in yield but disease control dropped slightly. The same clay and talc comparison gave similar results when used with Cuprocide and with Tribasic, indicating that the reaction of the diluent within the range represented by Cherokee clay and EM 23 talc had no significant influence on disease control. The substitution of rotenone for sulfur for use with Tribasic was not justified, since a significant decrease in yield resulted, accompanied by a decrease in disease control and an increase in trimmed waste. A Fermate plus talc dust (10-90) gave significantly better disease control and yields than

most of the fixed copper formulas. The Fermate-treated plants were large but rather yellowish in color. Heart rot in a mild form was quite prevalent in the plots treated with Fermate, and this, together with the yellowish tinge to the foliage, indicated that some type of host injury must have occurred in spite of the good growth that the plants made.

TABLE 12.—The influence of various supplemental materials and diluents on the performance of several fixed coppers in controlling early blight on celery in a mid-season planting at McGuffey in 1942

Treatments	Yield in tons per acre: Untrimmed	Yield in tons per acre: Trimmed	Percentage of trim	Percentage of foliage free of disease at harvest
COC-S + bentonite + EM 23 talc, 14-14-72	39.12	23.83	39.2	64
COC-S + bentonite + sulfur + EM 23 talc, 14-14-20-52	41.73	24.23	42.0	72
COC-S + bentonite + sulfur + EM 23 talc, 14-14-30-42	40.67	24.00	41.1	74
COC-S + sulfur + Cherokee clay, 8-7-85	41.65	23.25	42.6	62
Copper oxychloride + bentonite + EM 23 talc, 14-14-72	38.88	22.66	41.8	66
Copper oxychloride + bentonite + sulfur + EM 23 talc, 14-14-30-42	39.31	24.19	38.6	70
Cuprocide + bentonite + EM 23 talc, 8-14-78	39.30	23.59	39.9	74
Cuprocide + bentonite + sulfur + EM 23 talc, 8-14-30-48	39.41	23.57	40.2	84
Cuprocide + EM 23 talc, 8 92	40.42	23.80	41.2	70
Cuprocide + clay, 8-92	39.12	23.41	40.3	74
Tribasic + bentonite + EM 23 talc, 14-14-72	36.18	20.89	42.4	48
Tribasic + bentonite + sulfur + EM 23 talc, 14-14-30-42	39.67	22.56	43.2	62
Tribasic + bentonite + rotenone + EM 23 talc, 14-14-15-57	35.89	19.83	44.1	56
Tribasic + bentonite + Cherokee clay, 14-14-72	35.56	21.35	40.0	60
Tribasic + bentonite + Loomkill talc, 14-14-72	34.59	19.33	44.2	54
Tribasic + bentonite + Pyrax talc, 14-14-72	37.96	22.53	40.7	60
Fermate + EM 23 talc, 10-90	42.90	26.32	38.8	92
No treatment	30.61	17.30	53.6	24
Difference necessary for significance at the 5-per cent level	.....	1.95	....	8.9

A late planting of Utah celery at McGuffey was treated with a number of widely different materials in 1942. The results are shown in table 13. Late blight became very severe in the untreated check plots before harvest, with the result that growth and quality were greatly reduced. None of the treatments, with the possible exception of Fermate, gave satisfactory control of defoliation and stalk decay, in spite of the fact that the plots were sprayed heavily every 6 days. Fermate again gave the best disease control and the largest increase in yield. The heart injury observed in the earlier planting of Epicure was not noticed, but the celery did seem to be of slightly poorer quality than that treated with Bordeaux and some of the fixed coppers. Cuprocide (2-100), Bordeaux, and COC-S were of similar efficiency, but Tribasic gave slightly poorer control of blight. Cuprocide 1-100 was definitely inferior to the 2-100 formula. This was in contrast to the results obtained on carrots (12) where the stronger formula was somewhat injurious. Sulfur used alone as a spray material was significantly poorer than most of the copper-containing formulas.

12. Wilson, J. D. 1944. Ten years of carrot spraying with various copper-containing materials. Ohio Agr. Exp. Sta. Bimo. Bull. 29: 63-73.

TABLE 13.—Bordeaux, fixed coppers, Fermate, and sulfur on late-planted celery at McGuffey in 1942. Late blight became severe by harvest time

Treatments	Yield in tons per acre		Percentage of trim	Foliage score—Percentage of foliage free of disease at harvest
	Untrimmed	Trimmed		
Fermate, 2-100	18.64	10.55	43.4	78
Cuprocide, 2-100	15.51	9.34	39.8	68
Bordeaux, 8-8-100	15.76	9.14	42.0	68
COC-S, 4-100	16.27	9.11	44.0	76
Copper Hydro Arsenate, 8-100	14.74	8.46	42.6	56
Cuprocide, 1-100	14.50	8.19	43.5	60
Tribasic, 4-100	14.76	8.00	45.8	64
Copper oxychloride (R), 4-100	14.44	7.90	45.3	66
Wettable sulfur, 8-100	12.92	7.31	43.4	60
No treatment	8.16	4.08	50.0	18
Difference required for significance at the 5 per cent level	....	0.85	.. ..	9.6

A mid-season planting of Epicure celery at McGuffey was sprayed with various organic materials, Bordeaux, Tribasic with and without sulfur, and other fixed-copper compounds in 1943. Some of the data are listed in table 14. Early blight appeared in the planting soon after it was set and became progressively worse until shortly before harvest. The check (unsprayed) plots were so severely diseased and stunted that they would not have been harvested by a commercial grower.

TABLE 14.—Bordeaux, fixed coppers, organics, and sulfur on a mid-season planting of celery at McGuffey in 1943. Early blight appeared early, was persistent, and became severe by harvest

Treatments	Yield in tons per acre		Percentage of trim	Percentage of foliage free of disease at harvest
	Untrimmed	Trimmed		
Bordeaux mixture, 8-8-100	16.84	8.70	48.5	66
COC-S, 4½-100	18.18	8.44	53.5	67
Cuprocide, 2½-100	18.00	8.18	54.6	65
Tribasic, 4-100	16.76	7.85	53.2	64
Tribasic + sulfur, 4-8-100	20.59	12.19	40.1	76
Tribasic + sulfur, 2-16-100	22.47	12.41	44.8	76
Fermate, 2-100	19.11	9.90	48.2	71
He-175, 1-100	12.18	4.50	63.2	50
He-175, 2-100	16.85	7.67	54.5	65
No treatment	7.80	1.39	82.2	20
Difference required for significance at the 5 per cent level	....	1.05	....	9.5

Fermate again gave slightly better disease control than Bordeaux mixture or the fixed coppers and a significantly larger increase in yield. When sulfur was added to Tribasic, disease control and yield were both significantly improved and the percentage of waste in trimming was definitely reduced. The sulfur not only improved disease control when added to the Tribasic copper, but growth was strikingly improved. In other words, the sulfur seemed to improve the nutritional tone of the plants and helped them to outgrow the

stunting effect of the disease attack. He-175, a new organic fungicide chemically related to Fermate, controlled disease as well as the fixed coppers when used in the 2-100 formula but was definitely inferior at 1-100. This material offers considerable promise as a fungicide and may come into general use later.

The results with the different fixed coppers have been somewhat variable from year to year in the control of celery blights, but certain ones have been rather consistently near the top of the list in disease control and plot yield, whereas others have placed low just as consistently. The comparative ranking of six of these fixed-copper compounds and Bordeaux mixture over a period of several years is shown in table 15. In 38 individual comparisons between Bordeaux and fixed coppers (all used at the same metallic copper equivalent in formulas), Bordeaux has stood first in yield five times out of each six and the differences in yield have been significant in one out of every three comparisons. Copper A has outranked other fixed coppers in three of every four comparisons, and one in every five of these has been significant in terms of yield increases. COC-S has given better yields than other fixed coppers in two out of each three comparisons and 10 out of 27 of these have been significant. Cuprocide in various forms has scored approximately 50 per cent against other fixed coppers but only exceeded Bordeaux in one of eight comparisons. Tribasic, Copper Hydro 40, and Cupro-K all scored comparatively low against Copper A, COC-S, and Cuprocide (11 firsts out of 39 comparisons). In 15 comparisons with Bordeaux mixture this low group scored only one first in yield (by Tribasic) and this was not significantly better. Copper A, COC-S, and Cuprocide as a group scored five firsts in 23 yield comparisons with Bordeaux, but only one of these (Copper A) was significant; whereas Bordeaux was significantly better in four of the 23 comparisons. When these materials are compared on the basis of disease control (foliage score), Bordeaux was better than the fixed coppers as a group in 28 out of 33 comparisons, or almost exactly the same percentage as in yield comparisons (84.8 and 84.2 per cent, respectively). The fixed coppers placed in the same order as for yields in table 15, with some variations in percentages. These were 81.0, 69.0, 53.6, 46.1, 25.0, and 8.3 per cent of firsts for Copper A, COC-S, Cuprocide, Copper Hydro 40, Tribasic, and Cupro-K, respectively. In a series of comparisons in the control of carrot blights these seven copper compounds ranked in a somewhat different order. Bordeaux mixture was still first in 86.1 per cent of the comparisons. Copper A, Copper Hydro 40, Tribasic, COC-S, Cupro-K, and Cuprocide had scores of 72.0, 70.0, 65.0, 44.4, and 10.6 per cent of firsts, respectively. The low score of Cuprocide was, of course, due to the foliage injury it caused when used at comparable copper concentrations with the other materials. Thus, on the basis of the celery comparisons these seven copper compounds can be arranged according to their efficiency in controlling celery blights in the descending order in which they are given in table 15. Bordeaux mixture ranked first but not very far above Copper A and COC-S. Cuprocide and Copper Hydro 40 are in a third group in a virtual tie, and Tribasic was somewhat poorer. Cupro-K was definitely inferior.

TABLE 15.—Summary table of rankings of each fixed-copper compound with every other fixed copper and Bordeaux mixture on celery for 12 experiments in 7 different years. Data given as number of firsts in total number of comparisons

Treatments	Bordeaux	Copper A	COC-S	Cuprocide	Copper Hydro 40	Tribasic	Cupro-K	Percentage of firsts with other fixed coppers
Bordeaux with:	.. ..	5 in 7	6 in 8	7 in 8	4 in 4	7 in 8	3 in 3	84.2
Copper A with:	2 in 7	....	3 in 5	4 in 5	3 in 4	4 in 5	3 in 3	77.3
COC-S with:	2 in 8	2 in 5	....	5 in 8	2 in 2	8 in 10	2 in 2	70.4
Cuprocide with:	1 in 8	1 in 5	3 in 8	....	2 in 4	4 in 8	2 in 3	42.9
Copper Hydro 40 with:	0 in 4	1 in 4	0 in 2	2 in 4	....	1 in 2	1 in 2	41.7
Tribasic with:	1 in 8	1 in 5	2 in 10	4 in 8	1 in 2	....	0 in 2	37.0
Cupro-K with:	0 in 3	0 in 3	0 in 2	1 in 3	1 in 2	0 in 2	.. ..	16.7

SUMMARY

Both the early and late blights of celery occur every year in Ohio. Early blight is the more common but is less likely to cause severe crop losses than the late form. Either can be controlled only with difficulty during periods of weather that are especially favorable for its development.

The spray and dust formulas and the details of their application to control these blights of celery in Ohio were outlined by Wilson and Newhall in 1930. Since that time the fixed-copper compounds have been introduced and developed as fungicides. The performance of these materials in celery blight control has been observed in numerous experiments during the past 10 years, and still more recently various "organics" have been tested.

Bordeaux mixture was included as a standard or check treatment in nearly all experiments. It consistently ranked at or near the top of the list in blight control and yield increases. In 38 individual comparisons with fixed-copper compounds, it ranked first 32 times and was significantly better in 11 of those instances.

A summarized comparison (table 15) of six fixed-copper compounds in 12 experiments, conducted over a period of 7 years, showed Copper A to outrank its competitor in four of every five yield comparisons. It was followed in decreasing efficiency by COC-S, Cuprocide, Copper Hydro 40, Tribasic, and Cupro-K. The different materials ranked in the same order on the basis of blight control.

Spraying with various fixed coppers and Bordeaux caused some reduction in yield in the absence of disease. Bordeaux was more injurious than the fixed coppers in one experiment. The injury appeared to be partly physiological and partly mechanical in nature.

Dusting and spraying were of comparable effectiveness in controlling blight, although the often heard statement that "it takes a good job of dusting to equal a mediocre job of spraying" was just as true for celery blight control as it is for most other foliage diseases of vegetables. In one comparison of eight materials applied as dusts and sprays the two methods of application gave very similar results.

When the fixed coppers were subjected to temperatures of about 335° F. and then applied under a steam pressure of 100 pounds with a vapor (steam) sprayer, the degree of disease control was similar to that obtained with the usual hydraulic pressure applicators. Bordeaux was altered unfavorably at that pressure and temperature but was less affected and gave better control of disease at 75 pounds and 300° F.

The addition of spreaders and adhesives to the fixed coppers has not been justified in terms of significantly improved disease control or increased yields, although some benefit was usually observed from their inclusion in spray and dust formulas.

The addition of lime failed to improve the results obtained with the fixed coppers, and its use in this connection should be discouraged.

Halving the lime content of an 8-8-100 Bordeaux formula to an 8-4-100 had little effect on disease control and yield in the one experiment where it was tried, but it is possible that such a reduction would be justified in areas where any further addition of lime to the soil is undesirable.

A comparison of sprays applied at 4-, 6-, and 8-day intervals indicated that applications made every 6 days struck a favorable balance between the injury caused by sprays applied every 4 days and the insufficient control of disease that was furnished by the 8-day interval.

Sulfur used alone failed to control celery blights or significantly increase yields over untreated plots, but it did give very satisfactory results when added to spray and dust formulas that contained a fixed copper. It improved all of the fixed copper with which it was used and seemed to be particularly effective with Tribasic.

The addition of zinc (as Cal Zinc) to COC-S was of no significant benefit in one comparison, and the use of rotenone was not justified in another trial.

COC-S dust mixtures prepared with various diluents varied but little in disease control. An acid clay (Cherokee) differed little from an alkaline talc (EM 23) when used as diluents for COC-S, Cuprocide, and Tribasic.

Fermate has given good results on celery in three experiments on muck at McGuffey. It was similar to the best copper treatments in disease control and gave excellent yield increases. There was some evidence of host injury with a slight yellowing of the foliage and a tendency to increase heart breakdown in one experiment.

A review of the results obtained in these experiments indicates that at least three formulas of approximately equal merit may be recommended for the control of the early and late blights of celery in Ohio. Bordeaux mixture (8-8-100) will give a maximum of disease control and better than average yields. A mixture of any one of several fixed copper compounds and sulfur (4-8-100 as a spray or 14-20-66 with talc as a dust) usually gives an average degree of disease control and very good yields. Fermate (3-100 as a spray or 10-90 with talc as a dust) may be expected to give good disease control and excellent yields. Spray or dust applications should be made every 6 days from about 2 weeks after transplanting until just before blanching for maximum disease control. Sprays should be applied at approximately 150 gallons and dusts at 40 pounds per acre. The use of adhesives and wetting agents is optional with the grower.

A MOSAIC-TOLERANT, PICKLING-TYPE CUCUMBER

J. D. WILSON AND J. J. WILSON[1]

Cucumber mosaic has been present in the United States for at least 40 years and was considered by Chupp (1) to be one of the most important diseases of that crop nearly 20 years ago. Mosaic has been chiefly responsible for a reduction of 50 per cent, or more, in the cucumber acreage in many sections of Ohio during the past 10 years. The control measures available have been both inadequate and ineffective and the introduction of mosaic-resistant strains now seems to offer the best solution for the control (2, 3, 4) of this disease. The strain of cucumber mosaic known as "white-pickle", the Doolittle strain, or Cucumis Virus 1 (Smith) is the most destructive in Ohio. Another less common strain that has been described by Porter (5) differs from "white-pickle" in host range and symptoms. It does not affect the fruit and has a longer incubation period than the Doolittle strain. The terminal leaves of cucumbers affected by the Porter strain become yellow and rigid, whereas the Doolittle strain causes a drooping and mottling of the leaves. Both of these viruses have been used to test host resistance in the various lines now being developed and observed in Ohio (6).

Porter (7) found Chinese Long to be resistant to the "white-pickle" strain of mosaic. For several years Doolittle, Porter, and Beecher (8) have been testing the resistance to mosaic of numerous crosses between commercial strains and the resistant-varieties Chinese Long and Tokio Long Green. More recently Shifriss and others have been studying and classifying the degree of resistance of various cucumber crosses to mosaic (9). In 1937 a considerable number of named commercial strains were observed by the senior author and classified on the basis of their resistance to mosaic at Wooster (6). In 1938 these tests were transferred to Bowling Green, Ohio, where a cooperative experiment was arranged with the H. J. Heinz Company, of that city. All available commercial varieties, as well as various hybrids, were planted during that year. Several plants of each kind were inoculated with each of the two viruses mentioned above. Some of the hybrid lines proved to be quite tolerant

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1. Chupp, C. 1925. Manual of Vegetable Garden Diseases. The MacMillan Co., New York, N. Y.
2. Doolittle, S. P. 1920. The mosaic disease of cucurbits. U. S. Dept. Agr. Bull. 879: 1-69.
3. Doolittle, S. P., and M. N. Walker. 1924. Experiments on the control of cucurbit mosaic. Phytopath. 14: 56. (Abst.)
4. Clayton, E. E. 1929. Breeding for resistance to cucumber mosaic disease. Phytopath. 19: 85. (Abst.)
5. Porter, R. H. 1931. The reaction of cucumbers to types of mosaic. Iowa State Coll. Jour. Sci. 6: 95-129.
6. Wilson, J. D. 1939. Vine crop diseases. Ohio Agr. Exp. Sta. Ann. Rept. **57**, Bull. 600: 22. (Abst.)
7. Porter, R. H. 1930. The resistance of cucumbers to mosaic. Phytopath. **20**: 114 (Abst.)
8. Doolittle, S. P., et al. 1939. A hybrid cucumber resistant to bacterial wilt. Phytopath. **29**: 996-998.
9. Shifriss, O., et al. 1942. Resistance to mosaic virus in the cucumber. Phytopath. **32**: 773-784.

of mosaic. Of the commercial varieties only Mandarin showed any worthwhile resistance. Mandarin (10) is reported to be a segregate from hybridizing a Chinese cucumber with an American white spine variety. Shamrock, a mosaic-resistant hybrid of White Spine × Chinese Long that was introduced by the Iowa Experiment Station about 1934, was resistant in these preliminary tests. China and Chinese 3 Feet also were resistant in this experiment.

In 1939, a considerable number of cucumber strains and hybrids were assembled from various sources and a breeding program was started in an effort to develop a cucumber of the pickling type that would be at least tolerant of mosaic. Dr. S. P. Doolittle of the U. S. Department of Agriculture furnished a considerable quantity of seed that included several F_1 hybrids. At least one parent of most of these hybrids was known to be resistant to mosaic. Ohio 31 has been developed from an F_5 inbred of one of these hybrids and is a homozygous segregate of the hybrid Tokio Long Green × National Pickle. Fruits of Ohio 31 are equally as well shaped and uniform in type as those of the National. See figures 1 and 2.

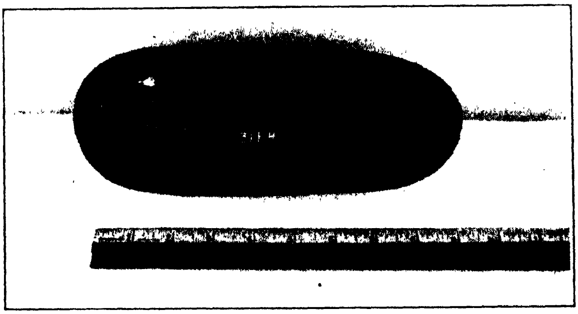

Fig. 1.—Ripe fruit of Ohio 31

When subjected to brining and processing, young fruits of Ohio 31 make excellent pickles. They are a pure black spine type, slightly less warted, darker green, more compact, and thicker fleshed than the National. Mature fruits are a mahogany brown color. Since the fruit has a small seed cavity and thick flesh, it is not a heavy producer of seed. The plants of Ohio 31 have a distinctive bluish-green foliage, coarse leaves, thick runners, and a vigorous root system, figure 2.

In 1942 and 1943, Ohio 31 was compared with National in field plots at Wooster. Aphids and mosaic were severe in 1942 and the plots of National were dead by August 20 after producing only a small crop. Ohio 31, under the same conditions, survived until mid-September although fruit production was not very great because of extremely dry weather. Ohio 31 produced 73 per cent more fruits than National in 1942. This was over a production period at least twice as long as that over which National was picked.

10. Tapley, William T., Walter D. Enzie, and Glen P. Van Eseltine. 1937. The Vegetables of New York. Vol. 1, Part IV, p. 100.

In 1943 these two varieties were again compared in plots involving a large number of replications. Ohio 31 and National were found to be equally susceptible to bacterial wilt. National reached its maximum production about 2 weeks earlier than Ohio 31 and, at midseason, had produced the larger crop. The plants of National with their numerous secondary runners developed a heavier growth than Ohio 31, which is of the primary-runner type. Aphids were scarce, but on August 9 (picking began on July 27) the first mosaic-spotted fruits appeared in National. By August 23 both the vines and fruits were severely affected. On that date, over 50 per cent of the fruits harvested from the plants of the National variety showed mosaic symptoms; whereas only 1.7 per cent of the Ohio 31 pickles were affected. The disease became steadily worse on National during the next 2 weeks and many of the vines died. The fruits of Ohio 31 never showed more than 3 per cent of mosaic. The comparative condition of the foliage on September 10 is shown in figures 3A and 3B, which represent Ohio 31 and National Pickle, respectively. Ohio 31 was picked for the last time on September 18 (8 weeks after the first picking), and only a small percentage of the fruits was affected with mosaic in this last picking. Although National produced as many pickles as Ohio 31 for the season, the number of disease-free fruits was considerably less, principally because of the very poor showing of National after August 15.

Fig. 2.—Vine and a hand-pollinated fruit of Ohio 31 at Bowling Green in 1942

These preliminary tests indicate that Ohio 31 offers definite promise as a variety to replace National in areas where mosaic is a limiting factor in pickle production, as it is in much of Ohio. Other lines more suitable as slicing cucumbers are also being observed, and one or more of these may be available for introduction during the next few years.

Fig. 3.—Relative vine condition of Ohio 31 (left) and National (right) on September 10, 1943, at Wooster

Note.—Seed of Ohio 31 will be available for distribution in small quantities (approximately 1 ounce) during the spring of 1944 by the Botany Department of the Ohio Agricultural Experiment Station at Wooster.

WHY ANIMAL BY-PRODUCTS ARE FED TO POULTRY

D. C. KENNARD

The greater use of plant protein concentrates, such as soybean oil meal, cottonseed meal, peanut meal, etc., in feeds for poultry, particularly with the minimum wartime use of meat, fish, and milk products, has introduced new problems in poultry feeding. Foremost of these problems is the minimum amount of feedstuffs from animal sources to supplement the plant proteins for the most economical results. Ample evidence is available to indicate the need of animal feedstuffs to supplement plant feedstuffs, but there is too little definite evidence to indicate the minimum requirements of animal products (their proteins, minerals, and vitamins) necessary to supplement plant feedstuffs for satisfactory economical production of eggs and poultry.

Too often meat, fish, and milk products are considered primarily as protein concentrates; whereas their greatest value in many rations may be derived from the needed minerals and vitamins they provide. In other words, meat, fish, and milk products should be considered as triple supplements of

proteins, minerals, and vitamins, anyone of which may be of primary importance in certain rations. Consequently, when minimum amounts of the animal products are used on the basis of their protein only, a deficiency of minerals and/or vitamins may occur.

An interesting example of the importance of 50 per cent protein meat scraps as a mineral supplement may be cited in connection with the national wartime animal protein conservation recommendations, in which the maximum amounts of animal products to be used for feeding poultry were set up on the basis of their protein content. A typical instance is the recommended 2.25 per cent protein from animal sources in a laying mash to be fed with grain. This, applied to 50 per cent protein meat scraps, would permit the use of 4.5 per cent in the laying mash to be fed with an equal amount of whole grain. The ration, on the basis of total feed intake, would then contain 2.25 per cent meat scraps (of which about 0.50 per cent would be bone meal) if equal amounts of grain and mash were consumed; however, usually more grain than mash is consumed. Thus, the reduced amount of meat scraps provides only about one-half the amount of bone meal to supply the necessary phosphorus, which, in turn, calls for an additional 1 to 2 per cent of phosphorus supplement, such as bone meal, defluorinated rock phosphate, or their equivalents.

TABLE 1.—Egg production, feed consumption, percentage mortality, and body weight of pullets as affected by the rations

October 19, 1922, to October 17, 1923—12 months

Ration with—	Experiment number and kind of pullets	Eggs per bird†	Feed consumption per bird‡			Mortality	Average body weight per bird
			Whole grain	Mash	Total feed		
			Lb.	*Lb.*	*Lb.*	*Pct.*	*Lb.*
20 per cent meat scraps* in mash	1—B. P. Rocks	137	46.93	31.64	78.57	7	5.36
	2—B. P. Rocks	159	46.91	34.33	81.24	20	5.65
	Average	148	46.92	32.98	79.90	14	5.50
10 per cent meat scraps* in mash, plus 2 per cent mineral mixture	1—B. P. Rocks	138	49.16	34.94	84.10	20	5.43
	2—B. P. Rocks	141	49.35	30.13	79.48	33	5.41
	Average	140	49.25	32.53	81.18	27	5.42
10 per cent meat scraps* in mash, no mineral mixture	1—B. P. Rocks	108	46.87	25.03	71.90	27	4.95
	2—B. P. Rocks	111	47.45	27.81	75.26	37	5.10
	Average	110	47.16	26.42	73.58	32	5.02
20 per cent meat scraps* in mash	3—Leghorns	124	32.42	27.89	60.31	16	3.22
10 per cent meat scraps* in mash, plus 2 per cent mineral mixture	3—Leghorns	125	33.75	26.59	60.34	14	3.30
10 per cent meat scraps* in mash, no mineral mixture	3—Leghorns	110	34.11	26.42	59.21	20	3.23
20 per cent cottonseed meal in mash, plus 4 per cent mineral mixture	3—Leghorns	105	32.40	24.35	56.75	10	3.23
20 per cent cottonseed meal in mash, no mineral mixture	3—Leghorns	49	32.33	21.13	53.36	28	2.91

*50 per cent protein.
†On basis of birds completing experiments.
‡On basis of hen days.

This has led to a critical scarcity of bone meal for feeding purposes equal to or greater than that of meat scraps. Thus it is that a partial solution of one problem may create another equally serious.

That the nutritive value of 50 per cent protein meat and bone scraps depends upon its mineral content (principally bone meal), as well as its protein, was clearly demonstrated by some of the early experiments of the Ohio Agricultural Experiment Station in connection with animal versus vegetable protein concentrates in rations for layers. These experiments were designed to determine whether the customary amount of 50 per cent protein meat and bone scraps, included in laying rations at that time, was needed primarily for the protein or the minerals provided. Could comparable results be secured from half the usual amount of meat scraps with a suitable mineral supplement? The experiments also included rations containing a vegetable protein concentrate, with and without the mineral supplement, instead of meat scraps. The results of three of the experiments are given in tables 1 and 2.

METHODS OF PROCEDURE

Experiments 1 and 2 were conducted with 30 B. P. Rock pullets in each group. Experiment 3 was conducted with 50 White Leghorn pullets in each group. The B. P. Rock in experiments 1 and 2 were confined indoors from October to June 7 and the Leghorns in experiment 3 to July 4, after which time all of the birds were on a bluegrass range until completion of the experiments in October. All groups were trapnested. The egg production was calculated on the basis of birds completing the experiment. The feed consumption was calculated on the basis of hen days.

RATIONS

Basal rations

Whole grain:	
Corn	60
Wheat	40
Mash:	
Ground corn	40
Wheat middlings	40
Meat scraps, 50 per cent protein	20*
Green feed:	
Cabbage or sprouted oats	

Oyster shell and mica grit before the birds at all times.

*When the meat scraps were reduced one-half, the percentage composition of the mash was 44.44 per cent ground corn, 44.44 wheat middlings, and 11.12 per cent meat scraps.
In the cottonseed meal rations, the 20 per cent meat scraps was replaced by the same amount of cottonseed meal.

The mineral mixture used in some of the rations was composed of steamed bone meal (for feeding purposes) 60, calcium carbonate 20, salt (sodium chloride) 20.

The cabbage was fed during the fall, after which it was followed by sprouted oats.

NOTE—In view of the more recent information on the dietary requirments for egg production, these rations are no longer recommended, especially when the layers are confined indoors or to bare yards.

DISCUSSION AND INTERPRETATION OF RESULTS

In all three experiments, the use of 10 parts of meat scraps in the mash supplemented with 2 parts of mineral mixture yielded egg production comparable to the control ration having 20 parts of meat scraps. Contrariwise, the egg production of the B. P. Rock pullets which received the ration with the reduced amount of meat scraps without the mineral supplement was 30 eggs per bird, or 21 per cent less. On this ration, the Leghorns in experiment 3 laid 15 eggs less per bird. It is obvious that, in this type of ration and management of the layers, the value of the larger proportion of meat scraps was due to the minerals provided rather than to the protein.

Of particular interest is the egg production by seasons given in table 2. As would be expected from these rations and from such management of the layers, the fall and winter egg production was low and much the same for all groups. During the spring period, while the pullets were still confined indoors, there was a greatly increased egg production though there was no decided difference between the different groups. It was not until the summer period, during which the pullets were out of doors on a bluegrass range, that the egg production of the pullets on the mineral-deficient rations (10 parts of meat scraps or 20 per cent cottonseed oil meal without the mineral mixture) was seriously affected. Presumably, the green feed and sunshine improved the diets of all groups, but, despite this, the layers on the mineral-deficient diet fell off rapidly in egg production.

TABLE 2.—Seasonal egg production

Ration with—	Experiment number and kind of pullets	Egg production by seasons					
		Fall and winter*		Spring†		Summer‡	
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
20 per cent meat scraps in mash	1—B. P. Rocks	30	22	55	54	52	42
	2—B. P. Rocks	36	26	60	60	63	50
	Average	33	24	57	57	57	46
10 per cent meat scraps in mash, plus 2 per cent mineral mixture	1—B. P. Rocks	31	22	54	53	53	43
	2—B. P. Rocks	27	20	50	49	64	51
	Average	29	21	52	51	58	47
10 per cent meat scraps in mash—no mineral mixture	1—B. P. Rocks	30	22	42	42	39	31
	2—B. P. Rocks	25	18	49	49	37	30
	Average	27	20	45	45	38	30
20 per cent meat scraps in mash	3—Leghorns	28	20	57	45	39	37
10 per cent meat scraps in mash, plus 2 per cent mineral mixture	3—Leghorns	30	22	59	48	36	33
10 per cent meat scraps in mash—no mineral mixture	3—Leghorns	34	26	54	43	22	21
20 per cent cottonseed meal in mash, plus 4 per cent mineral mixture	3—Leghorns	21	16	49	39	34	33
20 per cent cottonseed meal in mash—no mineral mixture	3—Leghorns	11	9	29	23	9	8

*October 19 to February 28.
†March 1 to June 7, experiments 1 and 2. March 1 to July 4, experiment 3.
‡June 8 to October 17, experiments 1 and 2. July 5 to October, experiment 3.

In light of recent information, it is obvious that the rations were all deficient in vitamin D and were on the border line with respect to vitamins A and G (riboflavin) necessary to meet the indoor requirements for winter egg production. While this seems a logical explanation of the low winter egg production, it does not account for the greatly increased egg production of all groups during the spring months when the birds continued to receive the same deficient rations indoors, where the environmental factors were much the same, except for higher temperature and some sunlight entering the pens. The sunlight may have been the determining factor. It is also difficult to explain why these layers did not respond with better egg production when finally given access to green feed and sunshine during the summer period. It is possible, however, that the pullet layers were permanently blighted by the long-time mineral and vitamin deficiencies to which they were previously subjected.

Since all of the pullets had free access to oyster shell, the principal mineral deficiency in the diets having reduced amount of meat scraps and cottonseed meal without the supplemental mineral mixture was probably due to a lack of phosphorus, which was provided by bone meal in the other rations. Lack of salt (sodium chloride) may also have been a factor in the mineral deficiency.

The vital role of ample phosphorus and sodium chloride where vegetable protein concentrates are used in rations for layers was clearly demonstrated with the two groups of Leghorn pullets in experiment 3. Somewhat comparable egg production and livability of pullets were secured in this experiment from cottonseed meal and 4 per cent of the mineral mixture as from an equal amount of meat scraps; whereas, the cottonseed meal ration, without the mineral supplement, was a decided failure. This was likewise true of soybean oil meal and peanut meal when used in similar experiments conducted by this Station (1).

The restricted use of 50 per cent protein meat, bone, and fish meals and the use of a greater proportion of soybean oil meal, corn gluten meal, peanut meal, cottonseed meal, etc., in poultry rations give rise to new problems and to liabilities of protein, mineral, and vitamin deficiencies. The greatest of these deficiencies may often be a mineral deficiency—particularly a phosphorus deficiency. An effective prevention or correction of a phosphorus deficiency is to add steamed bone meal (feeding grade), defluorinated rock phosphate, or their equivalents to the mash. The amount to be added will depend upon the composition, type, and purpose of the mash in question (2).

Bone meal (as such or as included in meat and bone scraps, tankage, and fish meal) or its equivalent, calcium carbonate or chick-size oyster shell or chick-size 90 per cent (or more) calcium carbonate limestone grit, and salt (sodium chloride) are essential minerals to be included in every mash in which half or more of the protein supplements are of plant origin. In some instances, the addition of manganese sulfate or carbonate at the rate of 4 to 10 ounces (depending upon the type and purpose of the mash) per ton of

1. Ohio Agr. Exp. Sta. Bimo. Bull. 1922. Nov.-Dec.: 171-178.

2. For information needed in calculation refer to Circular 76, 1944 Ohio Poultry Rations, Agr. Ext. Service, Ohio State University, Columbus, Ohio.

mash will be needed to prevent or control perosis (slipped tendon or hock-joint disease) of growing chickens and for good hatchability of eggs from the breeding flock. Occasionally under special circumstances, it may be advisable to use iodized salt to provide additional iodine.

The mineral ingredients, such as bone meal, calcium carbonate (oyster shell or 90 per cent or more calcium carbonate limestone), and salt, are generally included as integral parts of the feed formula the same as the other ingredients, rather than to add these minerals as a mineral mixture. For those who prefer to think in terms of adding a mineral mixture and for those who wish an effective mineral mixture devoid of non-essentials, the mineral mixture previously cited has much to commend it. It should, of course, be supplemented with manganese sulfate and/or iodine (iodized salt) when these minerals are needed for special purposes.

SUMMARY

By virtue of necessity and economy, plant protein concentrates have become a major source of protein for feeding poultry.

Plant protein products are generally low in the essential minerals and vitamins provided by feedstuffs from animal sources.

Meat, fish, and milk products are triple supplements of minerals, proteins, and vitamins any one of which may be the factor of primary importance in certain rations. Consequently, the protein content alone is a poor index to the supplemental value (or the maximum amount to be used) of animal products in poultry rations.

The use of soybean oil meal, corn gluten meal, cottonseed meal, peanut meal, etc., and the corresponding reduction of animal products in poultry rations have confronted poultrymen and the feed trade with many problems and complications.

Plant protein concentrates can be successfully used instead of animal products as a major source of the protein for poultry, when properly supplemented by the minerals and vitamins generally provided by meat, fish, and milk products.

WARTIME SHIFTS IN UTILIZATION OF FOOD AND FEED

W. E. KRAUSS

More than two years have passed since Secretary of Agriculture Wickard uttered his now famous slogan, "Food Will Win The War And Write The Peace." All are more conscious of the significance of such a statement today, for at last we have come to realize that food is a powerful weapon both in promoting war and maintaining peace.

Food has always been important, but the discovery of vitamins and the succeeding exploitation of these formerly mysterious substances have focused the public's attention both on food and on drug-store miracles. Along with such commercial exploitation has gone the slow, conservative educational process culminating, when the emergency arose, in a national nutrition program which manifests itself today in the nutrition committees that are to be found in almost every county and local defense council in the nation.

An understanding of body needs forms the best basis for proper food selection. For many years chemists, physiologists, and, more recently, nutritionists have been trying to identify completely the things of which foodstuffs and the human body are made and to establish standards of food nutrient intake that would permit optimum composition, and, therefore, optimum well-being of the body. From time to time efforts have been made to summarize the results of this kind of study in the form of a yardstick with which one's food nutrient needs might be measured. The League of Nations published such a yardstick in 1935, and more recently the Food and Nutrition Board of the National Research Council prepared a table of "Recommended Dietary Allowances" that should represent our standard of nutritional attainment (table 1). This yardstick tabulates the amounts of calories, protein, calcium, iron, and the various vitamins needed by both sexes and by the various age groups, considers degree of activity, and makes special provision for pregnancy and lactation.

A detailed consideration of the hows and whys of the need for specific food nutrients is unnecessary in this discussion. Rather, it would seem to be more pertinent to point out what foods contribute most to our nutritive needs and to compare our normal consumption pattern with the present and future in terms of dietary adequacy.

Outstanding in such an analysis would be the contribution made by milk with respect to all food nutrients except iron and copper. More striking still would be the discovery that as much energy is supplied by the skimmilk as by the fat in a given quantity of average milk and that, aside from vitamin A and certain essential fatty acids, the skimmilk fraction contributes all the protein, calcium, phosphorus, and water-soluble vitamins found in whole milk. This suggests the importance of utilizing all the constituents of milk. This matter is being given much attention, at the present time, in view of the fact that only about 60 per cent of the solids-not-fat produced in the United States is used for human food.

TABLE 1.—Recommended dietary allowances* (1)

1 Gram=1/28 of an ounce
1 Mg.=1/1000 of a gram
I. U.=International Units

	Calories	Protein	Calcium	Iron	Vitamin A**	Thiamin (B_1)†	Riboflavin	Niacin (Nicotinic acid)	Ascorbic acid	Vitamin D
		Grams	*Grams*	*Mg.*	*I. U.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*	*I. U.*
Man (154 lb.)										
Sedentary	2500					1.5	2.2	15		
Moderately active	3000	70	0.8	12	5000	1.8	2.7	18	75	¶
Very active	4500					2.3	3.3	23		
Woman (123 lb.)										
Sedentary	2100					1.2	1.8	12		
Moderately active	2500	60	0.8	12	5000	1.5	2.2	15	70	¶
Very active	3000					1.8	2.7	18		
Pregnancy (latter half)	2500	85	1.5	15	6000	1.8	2.5	18	100	400 to 800
Lactation	3000	100	2.0	15	8000	2.3	3.0	23	150	400 to 800
Children up to 12 years:										
Under 1 year‡	45 per lb.	1.6 per lb.	1.0	6	1500	0.4	0.6	4	30	400 to 800
1-3 years§	1200	40	1.0	7	2000	0.6	0.9	6	35	¶
4-6 years	1600	50	1.0	8	2500	0.8	1.2	8	50	
7-9 years	2000	60	1.0	10	3500	1.0	1.5	10	60	
10-12 years	2500	70	1.2	12	4500	1.2	1.8	12	75	
Children over 12 years:										
Girls, 13-15 years	2800	80	1.3	15	5000	1.4	2.0	14	80	¶
16-20 years	2400	75	1.0	15	5000	1.2	1.8	12	80	
Boys, 13-15 years	3200	85	1.4	15	5000	1.6	2.4	16	90	¶
16-20 years	3800	100	1.4	15	6000	2.0	3.0	20	100	

*Tentative goal toward which to aim in planning practical dietaries: can be met by a good diet of natural foods. Such a diet will also provide other minerals and vitamins, the requirements for which are less well known.

**Requirements may be less if provided as vitamin A; greater if provided chiefly as the pro-vitamin carotene.

†1 mg. thiamin equals 333 I. U.; 1 mg. ascorbic acid equals 20 I. U.

‡Needs of infants increase from month to month. The amounts given are for approximately 6-8 months. The amounts of protein and calcium needed are less if derived from human milk.

§Allowances are based on needs for the middle year in each group (as 2, 5, 8, etc.) and for moderate activity.

¶Vitamin D is undoubtedly necessary for older children and adults. When not available from sunshine, it should be provided probably up to the minimum amounts recommended for infants.

1. Food and Nutrition Board, National Research Council. 1943. Recommended Dietary Allowances. National Research Council Reprint and Circular Series, No. 115, Washington, D. C.

Meat is one of our principal sources of energy, varying from 400 calories per serving for the fatter cuts like pork, beef, and lamb to 180 calories per serving for leaner meats, like liver and fish. Meats also are on top as sources of protein, phosphorus, iron, and copper, particularly when the meat choice consists of such internal and glandular organs as liver, heart, sweetbreads, kidneys, and brains. Pork is an outstanding source of thiamin and all meats are fairly good sources of niacin.

Eggs are good sources of energy, protein, phosphorus, vitamins A and D, thiamin, and riboflavin, and their high value as food is best reflected in the recommendation that they be consumed at the rate of one a day or at least three or four per week, and that, along with milk, they are in great demand for lend-lease needs.

TABLE 2.—Apparent civilian consumption of food per capita (2)

	1935-39	1941	1943
Total meats (dressed), lb.	126	143	124
Fish, lb.	....	11.8	8.6
Poultry Products:			
Eggs, number	300	314	319
Chickens, lb.	18.0	19.5	28.4
Turkeys, lb.	2.7	3.6	3.9
Dairy Prodncts (except butter), lb.			
Total milk	806.5	814.0	770.5
Fluid milk and cream	342.3	350.1	396.7
Cheese	5.6	6.1	5.7
Condensed and evaporated	16.8	18.4	16.8
Ice Cream	9.6	13.7	9.5
Fats and Oils, lb.			
Butter	16.8	16.0	12.7
Margarine	2.3	2.2	3.6
Lard	11.0	14.3	14.0
Cooking fats	11.9	10.5	8.5
Other	6.3	8.4	7.6
Fruits, lb.			
Fresh	150.4	154.1	131.3
Canned	20.2	30.6	13.5
Frozen	0.7	1.2	1.7
Dried	6 1	3.7	4.1
Vegetables, lb.			
Fresh	....	206.4	173.1
Canned	....	42.4	29.7
Potatoes	130.7	127.1	129.7
Sweet potatoes	23.4	20.9	21.6
Beans, dry edible	8.9	8.8	7.9
Grains, lb.			
Wheat	222.4	220.1	240.8
Corn	57.3	64.8	73.7
Barley	21.6	22.6	27.8
Sugar, lb.	97.0	105.1	68.5
Coffee, lb.	14.0	16.1	9.6
Tea, lb.	0.7	0.8	0.2
Cocoa, lb.	4.4	4.8	3.0

2. The National Food Situation, April 1943. Bur. Agr. Econ., U. S. D. A., Table 6, pp. 22-23.

Bread and cereals constitute another food group that ordinarily is of importance chiefly as a source of energy, owing to the removal of valuable food nutrients in processing the materials that go into them. The bread and flour and the corn meal and hominy grits enrichment programs constitute great advances in making this food group a valuable contributor to our intake of some of the water-soluble vitamins and iron.

Fruits and vegetables should be considered primarily as sources of iron, vitamin A, vitamin C, and, to a lesser extent, of thiamin and riboflavin. Green leafy or yellow vegetables are particularly good sources of vitamin A and some, like green soybeans, are excellent sources of fat, protein, and the water-soluble vitamins. Citrus fruits and tomatoes are considered in the same breath as outstanding sources of vitamin C but the lowly potato, especially when eaten in the present English style (three times a day), also is an important source of this factor.

Fats and oils are concentrated sources of energy and certainly during the emergency they will be considered chiefly for this quality, along with palatability and whatever vitamin A they contain naturally or by fortification.

We must now ask: To what extent does our normal food consumption pattern contain these food groups, what changes have emergency conditions brought about, and how have these changes affected our food nutrient intake? An examination of the statistics (table 2) shows that apparent civilian consumption of food per capita in 1943 was not greatly different than that for the 1935-39 period. The biggest differences occurred in the consumption of chickens and turkeys (up 56 per cent), fluid milk and cream (up 16 per cent), lard (up 27 per cent), butter (down 24 per cent), margarine (up 57 per cent), canned fruits and juices, and dried fruits (both down 33 per cent), dry beans (down 29 per cent), corn (up 29 per cent), barley (up 29 per cent), coffee (down 31 per cent), tea (down 71 per cent), and cocoa (down 32 per cent). The effect of rationing and other restrictions can be determined by comparing our apparent consumption for 1943 with that for the last pre-war year, 1941, (table 2) when our consumption of all foods was at a high peak. Meats went back only 14 per cent or to the 1935-39 level, egg consumption was about the same, chickens were more frequent inhabitants of the table, more fluid milk was used than ever before, ice cream and butter were not always available, fresh and canned fruits were down considerably, as were fresh and canned vegetables, while cereal grain consumption increased rather sharply and sugar consumption went down quite markedly. What effect has this had on our nutritional status? Again we can refer to statistics (table 3).

This table does nothing more than show that, if the food supply were equitably distributed, the per capita intake of essential food nutrients would be adequate in 1943 and in some respects even better than during the pre-war period. That equitable distribution does not occur is well known and proven by the results of dietary surveys that have shown large segments of the population to be inadequately fed with respect to one or more nutrients. Purchasing power has, of course, a great deal to do with dietary status simply on the basis of quantity and variety of foods purchased. With increased purchasing power and rationing it is to be expected that the diets of many families, especially of the lower income groups, actually have improved. Increased

purchasing power has resulted in a greater total intake of food and rationing has resulted in greater use of beneficial rationed goods, for to some food stamps simply must be used up.

Another suggestion emanating from the analysis just made is that with purchasing power increased the supply of foods necessary for good nutrition becomes more important. It also becomes obvious that shifts in dietary patterns of the magnitude already experienced can occur without adversely affecting nutritional status. How far these shifts can go is the question of immediate concern.

TABLE 3.—Estimated nutritive value of civilian food supply (3)

Food Nutrient	Unit	Recommended	Consumed		
			1936-40	1942	1943
Food energy	Calories	2,800	3,220	3,230	3,180
Protein	Grams	66	82	86	90
Calcium	Grams	0.9	0.82	0.84	0.87
Iron	Milligrams	12	14	14	14.40
Vitamin A	I. U.	4,700	6,000	6,300	6,000
Riboflavin	Milligrams	2.3	1.8	1.8	2.0
Thiamin	Milligrams	1.6	1.7	2.1	2.2
Ascorbic acid	Milligrams	70	90	90	90
Niacin	Milligrams	16	15	16.1	18.1

3. Christensen, R. P. May, 1943. Using Resources to Meet Food Needs, Table 2. Bur. Agr. Econ., U. S. D. A.

The dietary patterns for various geographical sections of the country and for different income-level groups are well known. In a time of emergency there is a tendency to reduce these to a common basis so as to obtain more equitable distribution of available foods. Previous dietary habits cannot be completely ignored, because certain psychological soothing effects obtained from the mere mechanical process of eating have morale value of importance. At the same time, certain changes in food habits, involving even the use of substitutes or previously ignored food products, are not only desirable economically but will provide unsuspected nourishment. In this connection, it is of interest to recall a statement made many years ago: (4)

"Let a piece of the most tempting beefsteak be extracted with water or pressed to obtain broth or meat juice for an invalid, and the solid portion which remains, containing probably more than 95 per cent of the real food material present in the original meat, would be spurned by people as quickly as skimmilk and for the same reason.

"In many cases people, guided mainly by appetite, think they are buying food with more or less flavor thrown in when they are in reality buying flavor with a little food value incidently included. In the choice of natural foods, appetite is usually a fairly reliable guide to the selection of a proper diet, but in these days of sophisticated and modified foods, appetite alone will frequently lead one to spend his living on mere flavored husks; while the real food value of the article, shorn of its flavor, is allowed to waste."

4. Perkins. A. E. 1916. Misguided Appetite and The High Cost of Living. Ohi Agr. Exp. Sta. Mo. Bull. 1: No. 12.

In 1942, about 40 per cent of the food energy, 57 per cent of the protein, 73 per cent of the fat, 80 per cent of the calcium, 60 per cent of the phosphorus, 42 per cent of the iron, 38 per cent of the vitamin A, 9 per cent of the ascorbic acid, 57 per cent of the thiamin, 75 per cent of the riboflavin, and 64 per cent of the niacin were derived from livestock products, while the remaining percentages were of plant origin (5). About three-fourths of the calcium and one-half of the riboflavin came from milk products. Meats, poultry, and fish and grain products were the most important sources of thiamin and niacin, whereas vegetables and fruits were the chief sources of vitamin A and ascorbic acid. Whether or not our dietary nutrients will continue to come from these same sources and in the same proportions will depend upon the number of extra people we plan to feed, the length of the emergency period, and the type of agricultural production program that is decided upon. If it is assumed that food produced in the United States will feed many millions of civilians in countries other than the United States and that the period of emergency will not be brief, further shifts in the American dietary pattern can be expected. The nature and extent of such shifts will depend on whether the food production program will be based on maximum output of human food nutrients and efficiency of their utilization or on a long-time agricultural policy that respects physical maintenance of the soil and soil fertility and considers the psychological effect of drastic dietary shifts and the tremendous reverberations of attempting to maintain food rationing following the peace.

In determining the agricultural program, careful consideration will be given to efficiency of production of livestock products and to use of the resources available (land, labor, feed) in such a way as to contribute most to the national food suppiy. This involves an analysis of competition for use of resources among various livestock enterprises and between livestock and people. Tables 4 and 5 present such an analysis. From table 4 the relative efficiency of production of livestock products, in terms of specific nutrients, can be expressed as follows—

Calories: Hogs, whole milk, eggs, broilers and lambs, steers.
Protein: Whole milk, broilers, eggs, hogs, lambs, steers.
Calcium: Whole milk, eggs, broilers, hogs, lambs, steers.
Phosphorus: Whole milk, eggs, broilers, hogs, lambs, steers.
Iron: Eggs, hogs, broilers, lambs, whole milk, steers.
Vitamin A: Whole milk, eggs.
Thiamin: Hogs, eggs, lambs, whole milk, broilers, steers.
Riboflavin: Whole milk, eggs, hogs, lambs, steers, broilers.
Niacin: Hogs, broilers, lambs, steers, whole milk, eggs.

It is apparent that all livestock products have some merit as sources of certain food nutrients and as utilizers of farm resources, but the frequency with which they occur at the head of the list would point to emphasis on the production of milk (to be consumed completely) and eggs, with hogs and poultry meat not far behind and lambs and steers trailing. The position of roughage-consuming animals is materially improved when the calculations are made only in terms of feed grains and concentrates consumed.

5. Christensen, R. P. May, 1943. Using Resources to Meet Food Needs, Table 3. Bur. Agr. Econ., U. S. D. A.

TABLE 4.—Relative efficiency of production of human food nutrients from livestock (6)

	Calories	Protein	Calcium	Phosphorus	Iron	Vitamin A	Thiamin	Riboflavin	Niacin
	1000's	*Lb.*	*Gm.*	*Gm.*	*Mg.*	*1000 I. U.*	*Mg.*	*Mg.*	*Mg.*
Yield of nutrients per 1,000 feed units:									
Whole milk	276	31	472	372	805	776	117	700	398
All dairy products	227	19	292	228	515	731	68	412	226
Dairy enterprise	182	17	207	175	565	517	60	308	767
Eggs	113	20	39	150	1,931	716	146	358	45
Chickens	83	19	7	94	818	....	41	21	2,884
Broilers	98	23	8	110	963	....	48	25	3,393
Chicken enterprise	102	20	27	130	1,540	464	109	240	1,041
Hogs (pork and lard)	349	13	4	70	985	....	670	91	3,474
Steers	40	6	2	28	387	....	23	33	1,230
Lambs	85	9	3	60	816	....	135	92	1,372
Yield of nutrients per acre:									
Whole milk	352	39	603	475	1,028	991	149	894	508
All dairy products	290	25	385	291	659	933	87	527	289
Dairy enterprise	235	22	277	227	730	669	78	398	991
Eggs	144	26	49	193	2,473	916	188	458	57
Chickens	108	25	9	122	1,065	....	53	28	3,755
Broilers	117	27	10	131	1,146	....	57	30	4,041
Chicken enterprise	132	26	35	169	1,989	599	141	309	1,345
Hogs (pork and lard)	500	18	5	100	1,411	....	959	130	4,974
Steers	57	8	2	40	556	....	34	47	1,766
Lambs	115	13	4	81	1,102	....	183	124	1,853
Yield of nutrients per 100 man-hours of farm labor:									
Whole milk	791	89	1,354	1,066	2,309	2,226	335	2,008	1,141
All dairy products	651	55	864	654	1,479	2,096	195	1,183	649
Dairy enterprise	633	60	746	613	1,968	1,804	209	1,074	2,672
Eggs	313	56	108	419	5,378	1,993	408	996	125
Chickens	322	74	27	363	3,166	....	158	83	11,160
Broilers	279	64	23	314	2,739	....	137	72	9,655
Chicken enterprise	317	61	85	405	4,775	1,438	339	742	3,240
Hogs (pork and lard)	1,618	58	17	324	4,564	....	3,102	419	16,092
Steers	289	42	11	203	2,829	....	171	239	8,984
Lambs	521	58	20	364	4,981	....	827	563	8,377

6. Christensen, R. P. Using Resources to Meet Food Needs. May, 1943. Bur. Agr. Econ., U. S. D. A. Tables 8, 10, and 12.

TABLE 5.—Relative efficiency of production of human food nutrients from crops (7)

	Calories	Protein	Calcium	Phosphorus	Iron	Vitamin A	Thiamin	Vitamin C	Riboflavin	Niacin
	1000's	*Lb.*	*Gm.*	*Gm.*	*Gm.*	*1000 I. U.*	*Mg.*	*Gm.*	*Mg.*	*Mg.*
Yield of nutrients per acre:										
Wheat, whole flour	1,132	90	167	1,177	15,743	....	1,582	0	486	15,274
Wheat, white flour	833	56	35	237	2,351	0	155	0	103	2,329
Corn meal (yellow)	1,122	57	31	441	2,997	347	725	0	94	1,878
Cornflakes	595	29	25	185	4,466	0	0	0	0	837
Oats, rolled	987	78	202	910	12,961	0	2,018	0	374	2,499
Potatoes	2,283	118	348	1,300	19,656	1,074	2,412	265	1,331	31,374
Sweet potatoes	1,801	55	502	649	11,047	55,480	1,409	359	971	16,571
Sugar	6,634	0	0	0	0	0	0	0	0	0
Beans, dry	1,081	150	457	1,430	31,819	0	1,608	0	964	8,653
Peas, dry	1,248	190	257	1,399	21,150	932	4,440	0	1,236	6,343
Soybeans, whole	1,545	339	1,001	2,586	37,033	573	5,152	0	1,323	10,692
Soybeans (oil)	612	0	0	0	0	0	0	0	0	0
Cabbage	870	96	1,459	998	16,128	5,094	2,522	1,741	1,562	9,088
Carrots	2,685	166	2,381	2,291	48,330	431,354	3,652	430	4,278	88,963
Tomatoes	408	41	198	490	10,960	23,588	1,446	455	816	10,552
Apples	1,073	13	98	166	5,080	1,317	415	68	1,166	8,294
Peaches	939	18	150	397	10,483	31,271	369	150	1,106	17,568
Oranges	1,909	68	1,264	901	13,173	2,446	3,818	1,694	1,169	19,088
Yield of nutrients per 100 man hours of farm labor:										
Wheat, whole flour	12,582	1,002	1,852	13,078	174,930	....	17,584	0	5,398	169,722
Wheat, white flour	9,251	621	389	2,629	26,124	0	1,720	0	1,149	25,876
Corn meal (yellow)	4,109	211	114	1,614	10,977	1,272	2,655	0	346	6,879
Cornflakes	2,178	106	93	677	16,359	0	0	0	0	3,065
Oats, rolled	10,963	868	2,245	10,107	144,008	0	22,425	0	4,153	27,761
Potatoes	3,358	174	511	1,912	28,907	1,579	3,547	389	1,957	46,140
Sweet potatoes	1,583	48	440	569	9,691	48,670	1,236	315	852	14,537
Sugar	2,787	0	0	0	0	0	0	0	0	0
Beans, dry	4,159	576	1,756	5,501	122,384	0	6,183	0	3,706	33,283
Soybeans, whole	12,879	2,821	8,343	21,546	308,610	4,779	42,930	0	11,025	89,100
Soybeans (oil)	5,103	0	0	0	0	0	0	0	0	0
Cabbage	799	88	1,339	916	14,796	4,674	2,313	1,597	1,433	8,338
Carrots	829	51	735	707	14,918	133,141	1,127	133	1,320	27,459
Tomatoes	242	24	117	290	6,486	13,959	856	269	483	6,244
Apples	873	10	80	135	4,131	1,071	337	55	948	6,744
Peaches	751	14	120	318	8,387	25,017	295	120	885	14,054
Oranges	1,224	44	810	577	8,445	1,568	2,447	1,086	750	12,236

7. Christensen, R. P. Using Resources to Meet Food Needs. May, 1943. Bur. Agr. Econ., U. S. D. A., Tables 16, 19, 22, 23, 25, and 26.

Much has been heard about direct utilization of crops by humans rather than first feeding them to livestock. It can readily be shown that many more people could be fed if more of our crops were directly utilized (table 5). It must be remembered, however, that some of the feed fed to livestock is recovered in the manure and contributes to soil fertility, that lambs produce wool in addition to meat, that hides, inedible by-products for animal feed, and important pharmaceutical preparations are obtained from slaughtered animals, and that dairy cows, beef cattle, and sheep make use of large quantities of grass and other forages on land unsuited for cultivation. It must also be remembered that the story of nutrition is not yet complete, that animal products may be especially rich in some yet undiscovered nutritional factors, and that animals concentrate protein, vitamins, and minerals from plant sources into foods which are more palatable and often more digestible.

The food production pattern of the future may, therefore, be something like this: If feedstuffs continue to be short relative to livestock numbers, reductions in livestock and poultry numbers can be expected, with fat hogs, broilers, and fat cattle taking the major share of the cut. An attempt will be made to increase milk production and to utilize more fully all the solids of milk. High energy crops for direct human consumption, like soybeans, peanuts, potatoes, sweet potatoes, beans, and peas, will be encouraged; butter and lard substitutes may become increasingly abundant; and considerable dependence will be placed on home produce from victory gardens, home and local orchards, along with increased commercial production of green leafy and yellow vegetables. Bread may be fortified not only with iron, thiamin, niacin, and riboflavin, but with milk solids and soybean flour. The basis of the civilian dietary thus will be milk solids, eggs, enriched bread and cereals, green leafy and yellow vegetables (together with victory garden produce), fruits, potatoes, dried beans, peas, and nuts, and limited meats, especially of the high quality cuts.

Should this look into the future be sound, then some attention may need to be given to our present teaching and extension programs in the field of nutrition. Education, as desirable as it is always, is a slow process. For many years we have been teaching about the superior value of whole grain bread and the desirability of increasing milk consumption; nevertheless milk consumption over a long period of time increased but slightly and whole grain bread was something indulged in largely by food faddists. In a period of 2 years, milk consumption has increased markedly because of increased incomes and all the virtues of whole grain bread are innocently being foisted upon the public in the form of enriched white bread. The lesson to be derived from this is that factors other than education afford opportunities for putting into effect practices that education alone may require generations to accomplish. As unbalanced as a breakfast of coffee and doughnuts may seem to be to nutritionists, the fact remains that breakfast in many homes today, and particularly in homes of industrial workers or at drugstore counters, is the most inadequate meal of the day. Many breakfasts *do* often consist of coffee or a soft drink and doughnuts; hence, any plan that would fortify doughnuts or that would dramatize the teaching that breakfast should supply at least one-fourth of the daily food requirements would be desirable.

Although farm families may seem to be in a favorable position under a food rationing system, there are still many things to be taught that have underlying nutritional principles. Certainly much is already being done in the matter of food storage, food preservation, and cooking procedures that conserve food value. This must be continued and appended as new knowledge becomes available. Much needs to be done to teach the value of skimmilk and the many uses for it other than as a beverage or as calf and pig feed. The value of the tomato and the potato as sources of vitamin C in comparison with citrus fruits and the relative values of canned and fresh citrus fruits as sources of vitamin C need to be taught in order to permit wise expenditures of food money and ration points.

With farm labor scarce and the farmwife called upon more and more for other than household duties, suggestions for convenient kitchen arrangements and culinary short cuts will contribute much toward adequate family feeding and harmonious living. This problem is recognized as foremost in the feeding of families of industrial workers where the homemaker also is a war worker. Home economics and food laboratories should be experimenting with new food sources and new food combinations containing dried milk, dried yeast, and soybean and peanut flour, from which palatable dishes and attractive menus can be prepared for the convenience of the homemaker.

At the same time, our teachings regarding nutritional requirements and food composition, emphasizing that composition is more important than kind of food, should be continued and extended. Greater intimacy with food nutrient requirements and food composition will permit greater flexibility in the use of food ration stamps and will make easier, through understanding, the shifts, substitutions, and fortification programs that will need to accompany dietary pattern changes.

Because at times certain desired foods have been difficult to get, many people have erroneously concluded that we were approaching a serious actual food shortage. Not only were food crops larger in 1943 than in 1942, an excellent year, but the best available estimates indicate that the nutritive value of per capita civilian supplies exceeded the 1935-39 average. This does not mean that our desires for choice steaks, chops, roasts, and other things that might be termed "food frills" will be met; neither does it mean that we will go about munching corn, oats, wheat, and the like—litterally putting on the feed bag. In other words, while we cannot hope to satisfy our food wants, we probably will be able to satisfy all our food needs. Even in the midst of war, however, we cannot afford to ignore food preferences completely.

Finally, it should be emphasized, regardless of other complications and implications, that by encouraging the consumption of more of the abundant foods, by using foods more efficiently and in more varied ways, by reducing waste, and by learning and applying nutritional principles in the home and in the feedlot, we not only will be tiding ourselves over a critical period but will be well on the road to that degree of physical perfection that conserves a Nation's greatest natural resource—its people.

INFANT MORTALITY HIGHEST IN RURAL AREAS

A. R. MANGUS AND R. L. McNAMARA

The infant death rate is recognized as an important indicator of health conditions among different population groups. Information provided by the United States Bureau of the Census[1] shows that in Ohio the largest cities provide the safest environment for babies in their first year of life. The chance of dying during that most hazardous first year increases progressively with decreasing size of city and is greatest in rural areas.

In Ohio the mortality among white infants in cities of 100,000 or more population was 35 per 1,000 live births in 1940, but the rate in rural areas of the State was 46 per 1,000, or more than 30 per cent in excess of that in the metropolitan centers. Included in rural areas are farms and small places of less than 2,500 population, since data were not available for farms separately. Cities intermediate in size were also intermediate with respect to infant death rates, the rate being 39 in cities having 10,000 to 100,000 people and 43 in smaller places having from 2,500 to 10,000 population.

It should be noted that these rates are based on births and deaths allocated to place of residence and therefore make allowance for rural babies who are born or who die in urban hospitals. The data pertain to 1940, the latest year for which detailed information is available.

It is doubtful whether rural-urban and intercity differences in infant mortality are due to differences in the inherent vitality of the populations concerned, but it is known that the chance of survival through the first year of life is closely associated with social and economic conditions. When infant death rates were computed for different socio-economic areas of Ohio, it was found that their inverse correlation with level of living indexes was very striking. In the areas where levels of living were highest the infant death rates were lowest. Mortality among babies increased progressively in each lower level of living area. In the area with the lowest level of living index, the infant mortality rate was 58.4 per cent higher among rural and town residents and 64.2 per cent higher among city residents than in the area with the highest level of living index (table 1).

As indicated in table 1 infant mortality is correlated not only with level of living indexes but also with the percentage of births occurring in hospitals. In the urban-industrial area where infant mortality was lowest and levels of living highest, 76.4 per cent of all births occurred in hospitals. In the western-agricultural area where the infant mortality rate was higher, only 46.0 per cent of the births were hospital babies. Infant mortality was still greater in the transitional area and the proportion of hospital births was only 36.4 per cent. In the southeastern area with the lowest level of living and the highest infant mortality, only 22.8 per cent of all births occurred in hospitals.

[1]**Vital Statistics Rates in the United States 1900-1940.** United States Bureau of the Census, Washington, D. C.

While many factors are involved in regional differences in infant mortality, it is notable that the Ohio area with the lowest death rates among babies had nearly twice as many physicians per unit of population as did the area with the highest rates (table 1).

TABLE 1.—Infant death rates per 1,000 live births, and associated factors in level of living areas, Ohio 1940

Area	Infant death rate		Level of living index	Per cent of births occurring in hospitals	Number of physicians per 100,000 population
	Rural and town areas*	Urban areas†			
All areas	45.7	38.0	100	62.6	128
Urban-industrial	39.4	36.6	135	76.4	148
Western-agricultural	43.4	40.7	106	46.0	105
Transitional	49.3	46.4	80	36.4	80
Southeastern	62.4	60.1	50	22.8	75

*Including places up to 10,000 population.
†Places of 10,000 population and over.

The rate of infant mortality has been undergoing a rapid downward trend. In 1917 about one in each 11 babies born in Ohio died before the end of the first year, but in the period between the two Wars the over-all infant mortality rate declined 55 per cent. This decline was, however, very much more rapid in urban than in rural areas.

At the beginning of the last War it was safer to be born in the country or in a small city than in a large urban center, for then infant death rates were 28 per cent higher in cities of 10,000 and over than they were outside such centers. During the last decade however, the rural advantage was lost, as the improved mortality experience in rural areas lagged behind that in urban centers. For the State as a whole, the infant mortality rate in 1940 was at the level reached by the large cities 5 years earlier. In southeastern Ohio where infant mortality experience was least favorable, the 1940 rates in small towns and on farms stood at the level reached by the large cities as early as 1927.

Public health authorities assert that it is entirely possible to reduce infant mortality as low as 25 deaths per 1,000 births. If such a rate had been in effect in 1940 the lives of 1,000 rural and 800 urban babies would have been saved in Ohio alone. The steps that must be taken to reduce infant deaths in rural areas are fairly clear. Some of the outstanding needs are: effective programs for safe-guarding the lives of mothers and children; more ready access to physicians and such specialists as obstetricians and pediatricians; better access to hospital facilities and nursing services; effective programs of instruction in child care and nutrition; and more complete public health services for control of preventable diseases and for sanitary programs.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

For the year 1943 the cash income of the Ohio farmer was 27 per cent above that of 1942. Higher prices and a larger volume of sales were responsible for this increase.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 = 100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	......	101	101	101	100	105	101
1914	99	......	100	101	102	102	105	109
1915	102	......	105	98	103	107	106	112
1916	125	......	124	118	113	113	121	123
1917	172	......	149	175	140	119	182	201
1918	192	......	176	202	175	131	203	243
1919	202	......	202	213	204	135	218	270
1920	225	......	201	211	236	159	212	230
1921	142	......	152	125	164	134	132	134
1922	141	......	149	132	145	124	127	133
1923	147	......	152	142	160	122	134	147
1924	143	......	152	143	165	118	133	150
1925	151	......	156	156	165	110	159	180
1926	146	......	155	145	170	105	155	183
1927	139	......	153	139	173	99	147	171
1928	141	......	155	149	169	96	154	163
1929	139	......	154	146	169	94	151	172
1930	126	......	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	140
1939	113	103	121	93	117	76	95	140
1940	114	117	122	98	116	77	99	146
1941	127	170	131	122	138	80	121	185
1942	144	227	154	157	173	89	157	244
1942								
January	140	192	146	149	153	..	141	201
February	141	199	147	145	....	......	144	183
March	142	208	150	146	....	89	146	208
April	144	210	151	150	167	..	153	250
May	144	216	152	152	....	....	157	241
June	144	222	152	151	176	...	157	232
July	144	230	152	154	179	...	159	237
August	145	233	152	163	......	..	164	248
September	145	237	153	163	......	....	161	268
October	145	249	154	169	193	.....	165	290
November	146	258	155	169	.....	.	167	293
December	147	267	156	178	....	......	169	297
1943								
January	149	268	158	182	196	......	174	283
February	149	275	160	178	....	....	177	261
March	150	282	161	182	....	97	181	287
April	151	284	162	185	212	....	190	296
May	152	289	163	187	.....	....	197	318
June	151	293	164	190	221	.....	193	318
July	150	291	165	188	229	.....	192	320
August	150	298	165	193	....	......	198	333
September	150	301	165	192	.....	......	194	318
October	150	....	166	192	228	......	194	325
November	150	....	167	192	......	......	193	330
December	....	....	....	193	......	....	196	325

*SOURCE: Bureau of Business Research, The Ohio State University.

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OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO, U.S.A.

YOUR FRIENDS THE AUTHORS

J. D. Wilson and H. A. Runnels, both of the Department of Botany and Plant Pathology, are co-authors of an article on the use of fixed coppers for the control of Alternaria blight of ginseng. Both men are well qualified to discuss this subject, as they have spent 10 or more years searching for a satisfactory material for the control of this disease.

Runnels

The apple maggot often causes considerable damage to apples in Ohio. In this issue C. R. Cutright, Entomologist at the Experiment Station, and T. H. Parks,[1] of the Ohio State University, discuss the life history of the insect and give control measures. Dr. Cutright is also co-author with J. S. Houser, Chief of the Department of Entomology, of an article on a familiar pest—the rose chafer or rose bug.

Cutright

[1]Professor Parks is not pictured here.

Donald Comin is a member of the Station's Department of Horticulture. At the present time he is primarily interested in muck crops. Much of his work is carried on at the Muck Crops Experiment Farm at McGuffey, Ohio, and in this issue Mr. Comin reports on two phases of his work at the Experiment Farm.

Comin

J. H. Sitterley has been a member of the Department of Rural Economics and Rural Sociology since 1928. He has written many articles on Ohio agriculture, particularly on the subject of land utilization. Mr. Sitterley and Dr. Falconer here trace the trends in Farm Auction Sales; they offer some explanation to account for the present trends.

Sitterley

Old friends contributing to your reading pleasure are: J. D. Wilson, Wesley P. Judkins, Alex Laurie, J. S. Houser, Robert R. Paton, D. C. Kennard, V. D. Chamberlin, J. I. Falconer, J. T. McClure, and W. L. Robison.

CONTENTS

***ERRATUM*:** **Please note on the back cover a correction in the article "Placing a Value on Silage" which appeared in the January-February, 1944 Bimonthly Bulletin.**

COMPARATIVE ABILITY OF THE FIXED COPPERS TO CONTROL GINSENG BLIGHT

J. D. WILSON AND H. A. RUNNELS[1]

Fungi belonging to the genus Alternaria attack a wide variety of herbaceous plants, among which are numerous vegetables and the drug plant known as ginseng (*Panax quinquefolium* L.). The leaf spots caused by this group of fungi are frequently difficult to control except by the use of a good fungicide carefully applied in a properly timed spray schedule. This is particularly true of ginseng blight (caused by *Alternaria panax* Whetzel) in Ohio. The regularity and the severity with which this leaf spot appears each year, and the difficulty experienced by the grower in preventing foliage and seed destruction, have made its control an excellent measuring stick for classifying the fixed coppers on the basis of their fungicidal efficiency.

Bordeaux mixture is commonly recommended for the control of ginseng blight (1, 2), as it is for various other leaf spots caused by related fungi, such as the early blights of celery (3), tomato (4), and potato (5). The effectiveness of Bordeaux mixture in the control of ginseng blight and various other diseases is somewhat increased by the addition of calcium arsenate (6, 7). However, Bordeaux mixture is injurious to ginseng, as well as to some other crops, under certain environmental conditions (8, 9, 10). The fixed coppers, which are less injurious to most plants than Bordeaux mixture (4, 9), have come into general use as Bordeaux substitutes during the past 10 years, in spite of the fact that they seldom control foliage diseases quite as effectively (3, 10). During this period these fixed coppers have been compared with Bordeaux mixture on a variety of vegetable crops in Ohio (3, 5, 10, 11, 12) and on ginseng. The comparisons on ginseng were made from 1935 to 1940, inclusive,

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[1]The authors wish to acknowledge their indebtedness to Dr. J. A. Honabarger, of Warsaw, Ohio, for the use of portions of his ginseng garden during the period of these experiments.

1. Runnels, H. A., and J. D. Wilson. 1933. Control of Alternaria blight of ginseng with Bordeaux mixture and injuries accompanying its use. Ohio Agr. Exp. Sta. Bull. 522: 1-16.

2. Whetzel, H. H., *et al.* 1916. Ginseng diseases and their control. U. S. Dept. Agr., Farmers' Bull. 736: 1-20.

3. Wilson, J. D. 1944. The control of celery blights with Bordeaux, the fixed coppers with and without sulfur, and Fermate. Ohio Agr. Exp. Sta. Bimo. Bull. 29: 95-109.

4. Wilson, J. D., and H. A. Runnels. 1937. Five years of tomato spraying. Ohio Agr. Exp. Sta. Bimo. Bull. 22: 13-18.

5. Sleesman, J. P., and J. D. Wilson. 1943. Comparison of fixed coppers and Bordeaux mixture in the control of insects and diseases on muck-grown Irish Cobbler potatoes. Ohio Agr. Exp. Sta. Bimo. Bull. 28: 173-183.

6. Whetzel, H. H., *et al.* Calcium arsenate as a fungicide. Phytopath. 19: 83. (Abst.).

7. Wilson, J. D. 1944. Further observations on the control of tomato anthracnose. Ohio Agr. Exp. Sta. Bimo. Bull. 29: 56-63.

8. Wilson, J. D., and H. A. Runnels. 1931. Bordeaux mixture as a factor increasing drouth injury. Phytopath. 21: 729-738.

9. Wilson, J. D., and H. A. Runnels. 1937. The effect of various spray materials on tomato transplants. Ohio Agr. Exp. Sta. Bimo. Bull. 22: 58-65.

10. Wilson, J. D. 1944. Ten years of carrot spraying with various copper-containing materials. Ohio Agr. Exp. Sta. Bimo. Bull. 29: 63-73.

(11, 12, 13) in an effort to classify the fixed coppers according to their ability to control Alternaria leaf spot.

The spray schedule recommended by Whetzel (2) for the control of ginseng blight included four applications at intervals regulated by seasonal development of the ginseng plant. This schedule was used for several years by Runnels and Wilson (1), but it was found that the applications were spaced too far apart to give sufficiently good control of the disease during years especially favorable to defoliation. Toward the end of the season, infection often became so severe that few, if any, of the seed heads reached maturity because of the shelling of the seed after they became diseased.

In 1935 the authors were fortunate enough to obtain the use of portions of an excellent ginseng planting for further studies in the control of ginseng blight. Since a spray interval of approximately 20 days had been observed to be too long for good blight control, it was decided to compare this with another, in which the sprays were applied every 10 days. About this time the fixed coppers were beginning to appear in the experimental program (3, 4, 5, 9, 10, 11, 12) and it was decided to compare some of these with Bordeaux mixture. The results of the first comparisons are given in table 1.

The copper content of the fixed coppers varies from about 18 to 85 per cent (14), but, although these are now tested at comparable copper contents in disease-control studies (3, 5, 10), the importance of variations in this factor was not appreciated at the time the 1935 experiment was planned. Because of this all of the copper-containing materials, including the copper sulfate in Bordeaux mixture, were used at the same amount by weight in the various formulas of table 1.

The plot arrangement and the number of replications were such in 1935 and again in 1936 that it was not desirable to subject the data to statistical analysis. From 1937 to 1940, inclusive, all treatments were applied to 5-replicated plots in a random-distribution pattern. The plots necessarily had to be small and they involved approximately 200 plants, which was the number located between the posts used to support the lath shade for the ginseng planting.

An inspection of the data shows quite clearly that sprays applied every 10 days were much more effective in disease control than those applied at 20-day intervals. Bordeaux mixture having a copper content of 1.5 pounds in 100 gallons of spray material was more effective in disease control when applied at the 10-day interval than any of the fixed coppers at the same or higher copper contents (calculated as the metallic copper equivalent). Cuprocide at 5 pounds of copper in 100 gallons was more effective than the other fixed coppers, all of which were used at lower copper concentrations in the spray mixtures, since Cuprocide contains more copper per unit of weight than any of the other materials listed in table 1. Judged on the basis of disease control Wyojel bentonite was slightly more effective than wheat flour as an adhesive. Coposil and Bordeaux mixture were slightly injurious in the first application,

11. Wilson, J. D. 1936. The value of ''insoluble'' coppers in vegetable disease control. Proc. Ohio Veg. Growers' Assoc. 21: 99-104.

12. Wilson, J. D. 1938. Insoluble copper compounds for spraying vegetables. Proc. Ohio Veg. and Potato Growers' Assoc. 23: 35-41.

13. Wilson, J. D. 1939. New equipment and new materials for controlling vegetable diseases. Proc. Ohio Veg. and Potato Growers' Assoc. 24: 110-134.

14. Wilson, J. D., and M. A. Vogel. 1941. Density and flowability of insecticidal and fungicidal dusts and dust ingredients. Ohio Agr. Exp. Sta. Bimo. Bull. 26: 69-79.

and the foliage of the Cuprocide plots was tinged with purple by mid-season. Calcium arsenate, which had previously been recommended by Whetzel as a distinct aid in the control of ginseng blight (2, 6), was added to all of the spray formulas, but in spite of this the use of a 5-application schedule with the sprays at 20-day intervals failed to give very good control of disease during 1935 when infection was so severe that the untreated plants were completely defoliated by August 1.

In 1936 another group of fixed coppers was compared with Bordeaux mixture for the control of Alternaria blight of ginseng. The applications were made at 14-day intervals, the period chosen as a compromise between the 10- and 20-day interval used in 1935. Grasselli spreader and sticker (1-1600) was used in most of the formulas. Tar soap and fish oil soap were substituted for it in two formulas in which copper oxychloride (Copper A) was used as the fungicide. The data relative to this experiment are given in table 2.

TABLE 1.—Influence of timing interval between spray applications on the control of ginseng blight by various fixed coppers and Bordeaux mixture at Coshocton in 1935

Treatments*	Percentage of plants showing blight lesions on stem or leaves on August 15	
	Sprayed every 10 days	Sprayed every 20 days
Bordeaux mixture (6-6-100)	2.5	37.5
Cuprocide + Wyojel (6-6-100)	8.0	40.0
Cuprocide + flour (6-6-100)	12.5	40.0
Copper oxychloride + Wyojel (6-6-100)	42.5	70.0
Coposil + Wyojel (6-6-100)	45.0	72.5
Copper oxychloride + flour (6-6-100)	46.0	73.5
Coposil (6-100)	46.5	77.5
Basic copper sulfate + flour (6-6-100)	55.0	82.5
No treatment†	100.0	100.0

*All treatments contained 3 pounds of calcium arsenate in each 100 gallons of spray material.

†Blight had completely killed the foliage on untreated plants by August 1.

Blight was not as severe in 1936 as during the previous summer and, as a result, the untreated plots were not completely defoliated until about August 15. The papery lesions characteristic of the disease increased in number much less rapidly on the sprayed plants than on the check plots. This delay in disease development was evident for most of the treatments used throughout these experiments.

Bordeaux mixture again gave better control of Alternaria blight than any of the fixed-copper formulas. The use of wheat flour and Wyojel bentonite improved the adhesion of copper oxychloride. The leaves of the plants that received the first four treatments listed in table 2 were much darker green and had considerably fewer blight lesions on them at the end of the season than the plants in the remainder of the plots in this experiment. The general appearance of the plots that were treated with copper oxychloride plus tar soap was much better than that of the other fixed-copper plots and was comparable to the Bordeaux plot in this respect.

TABLE 2.—Comparative control of ginseng blight in 1936 by various fixed coppers, and the influence of different stickers and spreaders on the effectiveness of copper oxychloride (Copper A). Sprays were applied at 14-day intervals

Treatments*	Percentage of plants that had lesions on stem or leaflets on August 26	Treatments*	Percentage of plants that had lesions on stem or leaflets on August 26
1. Bordeaux mixture (8-8-100)	12.6	6. Copper A (4-100)	54.3
2. Copper A + flour (4-6-100)	17.8	7. Cuprocide (2-100)	56.4
3. Copper A + tar soap (4-1-100)	21.9	8. Copper A + fish-oil soap (4-1-100)	57.1
4. Copper A + Wyojel (4-6-100)	25.2	9. Copper phosphate (4-100)	82.0
5. Coposil (6-100)	47.4	10. No treatment	100.0

*Grasselli spreader and sticker was used with all formulas (except numbers 3 and 8) at ½ pint in each 100 gallons (1-1600).

The comparisons between Bordeaux mixture and a number of the fixed coppers continued in 1937. The data relative to the control of blight are given in table 3. Another measure of the degree of control obtained was introduced in 1937 when counts were made at the end of the season on the number of plants that matured good seed heads. Ginseng usually blooms in July in Ohio, and, if rains happen to be frequent during or just after bloom, many of the umbels become infected with Alternaria. This usually causes a failure of the seeds to develop or a later shelling of the green or nearly ripe seeds before they become fully mature. Since the seed crop has some value, it is important to save as much of it as possible by spraying. Blight became severe by the end of the season in 1937 and as a result only a few good seed heads remained by the middle of August.

TABLE 3.—Comparison of different Bordeaux formulas, various fixed coppers, as well as two adhesives and three spreaders with Cupro-K, in the control of ginseng blight at Coshocton in 1937

Treatments*	Percentage of plants showing blight lesions on stem or leaflets on August 5	Percentage of plants that matured seeds
Bordeaux mixture (8-4-100)	9.0	8.2
Bordeeux mixture (8-8-100)	11.8	4.0
Copper A (4½-100)	13.0	15.1
Bordeaux mixture (4-8-100)	36.4	3.8
Copper Zeolite (Z-O) (8-100)	46.4	13.2
Super Copper (1-100)	51.6	5.9
Copper Hydro 40 (8-100)	55.6	2.3
Coposil (8-100)	66.6	1.5
Cuprocide (2½-100)	68.4	2.0
Cupro-K + soya flour (8-4-100)	74.3	0.0
Cupro-K (8-100)	80.0	0.9
Cupro-K + fish-oil soap (8-⅛-100)	80.7	1.4
Cupro-K + tar soap (8-⅛-100)	82.3	0.0
Palustrex-B (2-100)	99.8	0.0
No treatment	100.0	0.0
Difference necessary for significance at the 5 per cent level	12.3	...

*Grasselli spreader and sticker (1-1600) was used with all formulas except as noted for fish-oil soap and tar soap. Wheat flour (4-100) was used as an adhesive with Copper A, Z-O, Hydro 40, Coposil, and Cuprocide and was also used with Cupro-K, except as noted for soya flour.

Two Bordeaux formulas that contained 8 pounds of copper sulfate in 100 gallons were similar to Copper A + flour in blight control. The fixed copper saved more seed heads than either of the Bordeaux formulas, however. The 4-8-100 Bordeaux mixture was considerably less effective in disease control, but it was better than any treatment but Copper A + flour. Super Copper, an ammoniacal copper carbonate (3), was similar in effectiveness to Copper Zeolite and Copper Hydro 40.

Cupro-K gave rather poor control of ginseng blight in this experiment, regardless of the various spreaders and stickers that were used with it. The different combinations that contained this copper compound did not differ significantly one from another. Palustrex-B, an emulsified copper resinate and pine oil (3), gave practically no disease control.

Ginseng blight was severe in 1938 and none of the fixed coppers were very effective in controlling it, as may be seen from the data of table 4. Copper A used with wheat flour as an adhesive gave a degree of control that was closely comparable to that of Bordeaux mixture. When the flour was omitted or was replaced with another material, the control was much less. This was a very striking example of the influence of an adhesive on the effectiveness of a fixed copper in disease control. The results obtained with Orthex and a rosin-residue sticker were somewhat disappointing. The foliage of the plants treated with Copper A plus Orthex became quite purple by mid-summer. This was an indication of either oil or copper injury. Infection by Alternaria became severe in late July, and by August 10, when the data of table 4 were collected, all of the untreated plants were defoliated. Defoliation was not complete on any of the treated plots at that time, but most of the plants treated with the fixed coppers showed one or more lesions on the leaves, stem, or seed head by that time. Only a small percentage of the seed heads in any of the plots was free of disease as early as August 10.

TABLE 4.—Comparative blight control by Bordeaux mixture and various fixed coppers, and the influence of several supplemental materials on the effectiveness of Copper A in 1938

Treatments*	Percentage of plants diseased on August 10	Percentage of defoliation	Percentage of plants that matured good seed heads
Bordeaux mixture (8-8-100)	26	10	19
Bordeaux mixture (8-4-100)	28	8	18
Copper A + flour (4½-4-100)	43	11	16
Copper A + Orthex (4½-⅛-100)	93	23	11
Copper A + rosin residue (4½-⅛-100)	98	48	10
Copper A (4½-100)	96	53	9
Tribasic (4-100)	100	69	5
Cupro-K (8-100)	100	94	1
No treatment	100	100	0
Difference necessary for significance at the 5 per cent level	12.0	....	....

In 1939 a considerable number of fixed-copper compounds was compared on ginseng at Coshocton and on celery at Willard (3). The data on ginseng are shown in table 5. The copper-containing materials were used in concentrations that furnished approximately the same amount of copper (stated as

the metallic equivalent) in each formula. Blight finally became severe by mid-August on the untreated plots, but the attack was both milder and later than usual. Many of the fixed coppers did as well as an 8-6-100 Bordeaux in 1939. This may have been partially due to the use of wheat flour as an adhesive with most of them and to the fact that blight did not become severe until rather late in the summer. The percentage of good seed heads was higher than usual. In fact, the influence that some of the treatments had on seed-head production was one of the most striking features on the 1939 experiment. Wheat flour (used in third treatment from top in table 5) again gave better results than such adhesives as Wyojel bentonite, Crown clay, or soya flour. Those compounds in which the copper was present as an oxychloride again gave good results (3, 10) in most instances. Brown cupric hydrate adsorbed on talc was more effective in controlling ginseng blight than it proved to be elsewhere in disease control when applied in its usual form (75 per cent copper as metallic); for instance, on tomatoes and various other vegetables (3, 10, 11, 12). Bordeaux applied every 14 days as a part of these trials was slightly more effective in blight control than that applied to adjacent plots by the grower.

TABLE 5.—The relative effectiveness of 13 fixed coppers and the influence of several adhesives on the control of ginseng blight in 1939

Treatments*	Percentage of plants showing blight lesions on stems or leaflets August 19	Percentage of plants that produced good seed heads
Brown cupric hydrate in talc (8-100)	51.3	28.1
Copper oxychloride-H (4-100)	54.2	42.4
Copper A (4½-100)	59.9	38.4
Coposil (8-100)	60.6	40.3
Copper Hydro (8-100)	66.1	25.0
COC-S (4-100)	66.4	42.8
Copper oxalate (10-100)	67.0	18.1
Tribasic (4-100)	67.5	35.0
Basicop (4-100)	70.0	33.7
Cuprocide 54-Y (4-100)	70.2	30.2
Basic copper arsenate (4½-100)	70.8	29.7
Copper A + Wyojel (4½-4-100)	72.9	19.3
Bordeaux mixture (8-6-100)	74.6	19.0
Bordeaux (commercial control)	80.0	15.0
Copper A + Crown clay (4½-4-100)	94.4	5.2
Copper A + soya flour (4½-4-100)	96.9	24.0
Copper naphthenate (2-100)	98.5	0.0
Cupro-K (8-100)	99.5	2.0
No treatment	100.0	0.0
Difference required for significance at the 5 per cent level	9.9	....

*Wheat flour was used as an adhesive with all fixed coppers except Cuprocide and as noted with three Copper A formulas.

Several of the formulas used in 1939 were somewhat injurious. Copper oxalate caused a slight bronzing of the ginseng leaves, as did Cuprocide and Copper A + clay. So much wetting agent was used with copper naphthenate in an effort to get it into solution that this mixture caused some injury.

Several fixed coppers were compared with Bordeaux mixture, Fermate, and phenothiazine in 1940. The data relative to this experiment are presented in table 6. Bordeaux mixture again gave the best control of disease on the

foliage but did not preserve as many seed heads as Fermate and some of the fixed coppers. No one of these copper compounds was significantly better than the rest. Adhesives, such as wheat flour, soya flour, and Wyojel bentonite, were all similar. Phenthiazine failed to control ginseng blight on either the leaves or the seed heads and was rather injurious to the foliage in the formula used. Fermate gave good control of Alternaria blight but caused some yellowing of the foliage at 6-100, which was probably more concentrated than would have been necessary for a good degree of disease control. Although disease attack was less severe than usual, the untreated plants were completely defoliated by late August. The percentage of good seed heads in these plots was again considerably better than that obtained by the grower in his spraying schedule that included Bordeaux mixture at approximately 2-week intervals.

TABLE 6.—A comparison of several fixed coppers, Bordeaux mixture, and Fermate on ginseng in 1940

Treatments*	Percentage of plants that showed blight lesions on Sept. 2	Percentage of plants that produced good seed heads
1. Bordeaux mixture (6-6-100)	11.7	30.0
2. Fermate (6-100)	12.6	43.7
3. Copper A (4-100)	21.1	43.3
4. Cuprocide (yellow) (2½-100)	22.0	42.9
5. Copper A + soya flour (4-6-100)	23.4	40.0
6. Basicop (4-100)	25.0	30.0
7. Tribasic (4-100)	26.2	31.0
8. COC-S (4-100)	27.2	46.2
9. Copper A + Wyojel (4-6-100)	27.5	30.0
10. Copper A + Safe-N-Lead + tar soap (4-1-⅛-100)	48.2	37.5
11. Phenothiazine + Wyojel + lime (6½-3-6-100)	100.0	0.0
12. No treatment	100.0	0.0
Difference necessary for significance at the 5 per cent level	7.2	....

*Grasselli spreader and sticker was used with all formulas (1-2000) but Fermate (2) and Copper A plus soap (10). Wheat flour was used with formulas 3, 6, 7, and 8 at the rate of 6 pounds in 100 gallons.

An inspection of the data of tables 1 to 6 indicates that certain treatments have rather consistently given better control of ginseng blight than have others, and still others have been consistently poor in this respect. The comparative rankings of nine different materials that were tested more than once over a period of 6 years have been summarized in table 7. Other materials that were included only once are listed at the bottom of table 7. In assembling the data for this table, the ranking of each treatment was considered with respect to every other treatment used in a given experiment. For instance, in table 5, Coposil was better than Copper Hydro 40, but not significantly so. Coposil was also better than copper naphthenate and in this instance it was significantly better. The occurrence of a significant difference in disease control is noted in table 7 by the letter "S". Thus, Coposil gave better disease control than the other fixed coppers with which it was compared in 10 of 16 instances (See last column of table 7), but in only one of these was there a significant difference.

TABLE 7.—Summary table of rankings of each fixed-copper compound with other fixed coppers and Bordeaux mixture on ginseng in six different experiments in 6 different years from 1935 to 1940. Data given as number of firsts in total number of comparisons*

Material	Bordeaux mixture	Copper A	Copper Hydro 40	Coposil	Tribasic	Cuprocide	COC-S	Basicop	Cupro-K	Total of comparisons with fixed coppers only
Bordeaux mixture better than	....	5 in 6 2 S	1 in 2 1 S	3 in 4 1 S	2 in 3 2 S	4 in 5 2 S	1 in 2 1 S	2 in 3 1 S	3 in 3 3 S	21 in 28 13 S*
Copper A better than	1 in 6 1 S	....	2 in 2 1 S	4 in 4 1 S	3 in 3 1 S	4 in 5 1 S	2 in 2	3 in 3 1 S	3 in 3 3 S	21 in 22 8 S
Copper Hydro 40 better than	1 in 2	0 in 2	........†	1 in 2	1 in 1	2 in 2 1 S	1 in 1	1 in 1	2 in 2 2 S	8 in 11 3 S
Coposil better than	1 in 4	0 in 4	1 in 2	....	1 in 1	3 in 4	1 in 1	2 in 2	2 in 2 1 S	10 in 16 1 S
Tribasic better than	1 in 3	0 in 3	0 in 1	0 in 1	....	1 in 2	1 in 2	1 in 2	2 in 2 1 S	5 in 13 1 S
Cuprocide better than	1 in 5	1 in 5	0 in 2	1 in 4	1 in 2	....	1 in 2	1 in 2	2 in 2 1 S	7 in 19 1 S
COC-S better than	1 in 2	0 in 2	0 in 1	0 in 1	1 in 2	1 in 2	....	1 in 2	1 in 1 1 S	4 in 11 1 S
Basicop better than	1 in 3	0 in 3	0 in 1	0 in 2	1 in 2	1 in 2	1 in 2	....	1 in 1 1 S	4 in 13 1 S
Cupro-K	0 in 3	0 in 3	0 in 2	0 in 2	0 in 2	0 in 2	0 in 1	0 in 1	....	0 in 13

*S=Excess above comparative treatment great enough to be statistically significant.

†Alternaria leaf spot control furnished by materials used in single trials was as follows—

Fermate was similar to Bordeaux and better than any fixed copper.
Copper oxychloride by Harshaw above Bordeaux and all other fixed coppers but Brown Cupric Hydrate on talc.
Brown Cupric Hydrate adsorbed on talc ranked above everything else used in one experiment.
Copper oxalate was similar to COC-S in one experiment.
Basic copper arsenate was similar to Cuprocide.
Copper phosphate was below all other fixed coppers and Bordeaux.
Copper naphthenate was below all other fixed coppers but Cupro-K.
Super copper above five fixed coppers and below 2.
Copper Zeolite above four fixed coppers and below 1.
Palustrex-B below everything it was compared with.
Phenothiozine poorer than all fixed coppers in the experiment in which it was used.

Bordeaux mixture was better than the fixed coppers with which it was compared in 5 of a total of 6 years and outranked these compounds in 75 per cent of the individual instances in which it was compared with them. It was significantly better in nearly 50 per cent of the comparisons listed in table 7. Copper A ranked even better than Bordeaux mixture in comparison with other fixed coppers but was outranked by Bordeaux in five of six comparisons. Copper Hydro 40 and Coposil were similar to each other in controlling ginseng blight, but both failed to outrank Copper A in any comparison with it. Tribasic, Cuprocide, COC-S, and Basicop constitute a group in which each member gave similar results but all ranked below 50 per cent in comparison with a group that included Copper A, Copper Hydro 40, and Coposil. Cupro-K failed to outrank any other fixed copper in a total of 13 comparisons.

Both an experimental copper oxychloride and a sample of brown cupric hydrate adsorbed on talc that were furnished by The Harshaw Chemical Company and Fermate gave satisfactory control of ginseng blight in single tests.

SUMMARY AND CONTROL RECOMMENDATIONS

Ginseng blight occurs in near-epidemic form nearly every year in Ohio. Control, sufficiently good to preserve the foliage and any more than 50 per cent of the seed heads, is difficult to obtain.

The former recommendation of four applications of Bordeaux mixture, at intervals regulated by various stages of host development, was found to be ineffective in most instances under Ohio conditions.

The yearly recurrence of ginseng blight in seve. form has made its control a good criterion, or gauge, of the fungicidal efficiency of various experimental copper-containing spray materials.

A comparison of 10- and 20-day intervals between applications in 1935 showed disease control to be much superior with the 10-day period, and in later experiments a 14-day interval was used.

A summarized comparison of numerous copper-containing fungicides for a 6-year period showed Bordeaux mixture to give the best control of Alternaria lesions on the foliage, but some of the fixed coppers gave as good or better seed-head protection.

When a group of materials, in which each member was compared with others in the group in at least 11 instances, was arranged in the decreasing order of their effectiveness, Bordeaux ranked first, followed closely by Copper A. Copper Hydro 40, Coposil, Tribasic, Cuprocide, COC-S, Basicop, and Cupro-K followed Bordeaux and Copper A in that order. This ranking of the fixed coppers was somewhat similar to that given earlier on celery (3) and carrots (10) in that Copper A ranked first in all three instances and Cupro-K placed at or next to the bottom of the list. The intermediate positions varied considerably, however, for the different materials in the three lists.

The results obtained in these experiments, as well as experience gained in trying to control various diseases of vegetables caused by other species of Alternaria, have led the authors to change slightly their former recommendations (1) for the control of ginseng blight.

The interval between sprays has been shortened to 14 days with the starting and stopping dates unchanged. The inclusion of calcium arsenate in all applications is suggested to improve disease control and afford any needed

protection against chewing insects. Bordeaux mixture (6-6-100 or 8-8-100), plus 4 pounds of calcium arsenate, plus some good wetting agent in the quantity recommended by the manufacturer, is first choice. The first application should be made as soon as the majority of the plants are up in early May and the last about 3 weeks after bloom. This schedule will require six or seven applications during the average season.

Since Bordeaux mixture is likely to injure the plants in woodlot plantings during drouth periods (1), it is advisable to substitute one of the more effective fixed coppers in such locations. A typical formula would be Copper A, plus calcium arsenate, plus flour or bentonite (4-4-4-100). A wetting agent should also be added. If a fixed copper is used that has a metallic copper equivalent considerably above or below 50 per cent, the amount should be adjusted to furnish approximately 2 pounds of copper in each 100 gallons of spray material.

THE RESPONSE OF SOME MUCK CROPS TO THE APPLICATION OF MINOR ELEMENTS

DONALD COMIN[1]

For some time several Agricultural Experiment Stations have been recommending various of the so-called "minor elements" for use with crops grown on muck soils of their states. Several proprietory mixtures of minor elements have been placed on the market under various trade names to sell for as high as 100 dollars per ton. Many fertilizer manufacturing companies and smaller fertilizer mixing plants have, in the past, been preparing mixtures on order to contain various of the minor elements in various percentages.

In order to obtain an indication of the need for certain of the minor elements on the muck soils of Ohio, a preliminary test was made using copper sulfate, manganese sulfate, and a proprietory mixture containing 55 per cent manganese sulfate, 25 per cent copper sulfate, 10 per cent zinc sulfate, and 10 per cent iron sulfate.

These materials were applied on one-one-hundred-eightieth-acre plots in three different amounts—i. e., 50, 150, and 250 pounds per acre—which could be averaged for the yield on one-sixtieth-acre plots for each of the three different minor element treatments. This procedure was followed in order that any differences in yield secured from differing amounts of the minor elements could be detected from the small plots, while the significance of the

[1]The author wishes to express his appreciation to Harry Obenour, foreman of the State Muck Crops Experiment Farm, McGuffey, Ohio, for his help in planting and caring for the crops.

yields could be increased by using the mean yields secured from all plots of any minor element treatment. Three non-treated control plots were included and all plots were randomized within the experimental area.

The muck was located on the State Muck Crops Experiment Farm at McGuffey, Ohio, and represented soil in a good state of fertility through applications of 1,000 pounds per acre annually of an 0-9-27 fertilizer. The soil reaction varied between pH 5.5 and 5.8. Accordingly, one would expect some response to the copper applications in this acid soil but would not expect responses to manganese unless the soil were alkaline or only very slightly acid.

TABLE 1.—The response of some muck crops to the application of minor elements

On muck soil at McGuffey, Ohio, 1940

Minor element, pounds per acre	50	150	250	Mean yield	Increased yield from minor element	
					Tons	Per cent
Spinach, tons per acre						
Manganese sulfate	7.53	5.96	7.64	7.04	0.49	7.5
Copper sulfate	8.00	6.21	6.71	6.97	0.42	6.4
Proprietory mixture*	6.76	7.34	7.40	7.17	0.62	9.5
Control	7.43	6.20	6.02	6.55	....	....
Cabbage, tons per acre						
Manganese sulfate	23.87	22.75	20.79	22.47	2.01	9.8
Copper sulfate	22.26	22.68	22.96	22.63	2.17	10.6
Proprietory mixture*	22.82	21.07	21.42	21.77	1.31	6.4
Control	21.42	19.95	20.02	20.46		
opped table beets, tons per acre						
Manganese sulfate	9.47	8.71	8.40	8.86	2.03	29.7
Copper sulfate	9.85	7.09	9.64	8.86	2.03	29.7
Proprietory mixture*	7.25	9.01	7.43	7.90	1.07	15.7
Control	7.43	6.62	6.44	6.83	....	....
Topped table beets, late, tons per acre						
Manganese sulfate	9.76	9.14	9.24	9.38	1.87	24.9
Copper sulfate	11.08	9.23	11.04	10.45	2.94	39.2
Proprietory mixture*	6.84	10.83	7.80	8.49	0.98	13.1
Control	9.02	7.56	5.96	7.51	....	....
Onions, bushels per acre						
Manganese sulfate	449	386	404	413	2	0.4
Copper sulfate	479	408	423	437	26	6.3
Proprietory mixture*	472	494	461	476	65	15.8
Control	432	398	402	411	....	....
Sugar beets, tons per acre						
Manganese sulfate	22.05	21.88	21.47	21.80	0.90	4.3
Copper sulfate	21.36	22.39	20.27	21.34	0.44	2.1
Proprietory mixture*	20.82	21.94	21.36	21.37	0.47	2.3
Control	22.22	21.25	19.23	20.90	....	....

*Es-Min-El, abbreviation for Essential Mineral Elements, a product of the Tennessee Corp., analyzing 55% $MnSO_4$, 25% $CuSO_4$, 10% $ZnSO_4$, and 10% $FeSO_4$.

In table 1 are given the calculated acre yields of each crop from each plot so that comparisons may be made between the varying amounts of the minor elements applied. The mean yields of the three plots receiving any one treatment are also given as a means of determining more accurately the effects of any treatment as compared with any other treatment, including the no-treatment or control plot. To determine the magnitude of the effects of treatments the increased yield from treatments above the control plot are expressed in tons, or in bushels in the case of onions, and in per cent.

It should be pointed out that in this preliminary experiment there were not a sufficient number of plots of any of the treatments which would allow an accurate determination of the number of bushels or tons required for a significant difference between treatments.

An examination of table 1 shows a small but consistent increase from all treatments. Copper sulfate produced the largest increases with cabbage, late table beets, and the same increase was obtained from manganese sulfate on early table beets. Manganese sulfate produced the largest increases with sugar beets. The proprietory mixture produced the largest increases with spinach and onions.

There was no discernible difference between larger and smaller applications of each treatment. Topped table beet was the only crop to show sizeable increases from any of the treatments. It is interesting to note that manganese sulfate, as well as copper sulfate, produced sizeable increases with this crop. The proprietory mixture apparently supplied fully the requirements of all acrops for copper and manganese, as evidenced by the comparative yields.

As has been pointed out by others, small inexpensive applications of both manganese and copper usually result in better color in many vegetable crops (such as, beets, spinach, and onions) grown on muck soils.

Although it may be difficult to prove that greatly increased yields will always result from these minor element applications, there is evidence [Michigan (1) and New York Agricultural Experiment Stations (2)] that onions have a better color and increased resistance to insects and diseases. The same is true of beets and other vegetable crops. Undoubtedly, the effect of the minor elements would have been more pronounced had the soil of this experiment been more acid or more alkaline.

In the light of these preliminary results, it may be concluded that table beets should receive 50 pounds or more per acre of both copper and manganese sulfates, or their equivalent in the form of some proprietory mixture, when the soil is a muck with a reaction between pH 5 and 6. Whether the other crops included in this experiment should receive these minor elements might be open to question from the results here presented. Certainly it would do no harm to supply in the fertilizer applications small percentages (5 to 10 per cent) of both minor elements, since their cost per acre is negligible and since they have not depressed the yields—on the contrary, they have cqnsistently increased them to a small extent.

Initial applications might be all that would be required and it is probable that at least some of the copper as supplied in copper-bearing fungicides, if used on the muck area over a period of years, would supply the copper which is needed or beneficial to these crops.

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1. Harmer, Paul M. 1932. Muck soil management for onion production. Mich. Agr. Exp. Sta. Ext. Bull. 123: 1-23.
2. Knott, J. E. 1933. The effect of certain mineral elements on the color and thickness on onion scales. Cornell Univ. Agr. Exp. Sta. Bull. 552.

It should be pointed out that applications of lime to acid muck soils will have somewhat the same effect as is secured by applications of manganese, since lime will tend to make the soil more alkaline and thus bring back into solution in the soil the manganese which is less soluble in more acid solution.

In another experiment at McGuffey during 1932 the onion yields resulting from applications of lime were as follows[2]:

Treatment	Yield of onions, in bushels per acre	
	1932	1933
No lime	178	620
2 tons lime	275	703
4 tons lime	225	660
12 tons lime	....	547

Two tons of lime thus gave the largest increases in yield both years and might eliminate the necessity for applications of minor elements in time.

[2]Data supplied by Dr. J. D. Wilson, of the Department of Botany and Plant Pathology of the Ohio Agricultural Experiment Station.

GROWING CARROTS ON MUCK SOIL

DONALD COMIN[1]

The carrot has become a very popular vegetable from the consumers' standpoint, since nutrition specialists have pointed out its value in the human diet. According to the "Agricultural Statistics" of the U. S. Department of Agriculture for 1942, the acreage planted to carrots increased from 7,000 acres in 1921 to 33,000 acres in 1931 and to 49,000 acres in 1941. The production is estimated at upward of 17,000,000 bushels.

Carrot production is of two general classes—the northern, or summer, crop, considerable quantities of which go into storage; and the southern, or winter, crop, which appears on the markets during the winter in the form of bunched carrots.

During the period 1930-1939 New York state lead in the production of the late crop, averaging 2,000 acres, according to U. S. Census. Michigan was second in production, with 800 acres; and Ohio was sixth, with 550 acres. In 1941 Ohio increased this average acreage to 700 acres, which was slightly above the acreage in Michigan for the same year.

Ohio growers are primarily interested in the late carrot crop, and the largest portion of this crop is grown on the black or muck soils of the State. This type of soil is loose, well aerated, and relatively high in moisture and nitrogen during the period the carrot crop is growing. These factors, together with genetic factors, are responsible for the large, smooth, unbranched roots and large yields obtained on muck soils.

[1]The author wishes to express his appreciation to Harry Obenour, foreman, State Muck Crops Experiment Farm, McGuffey, Ohio, for his help in planting and caring for the crops.

The carrot, because of its wide climatic and soil adaptation, is grown as a home garden crop, as a market garden crop for selling in nearby cities, and as a truck crop for shipment or for storage. Large areas are planted to carrots to provide for summer marketing or for storage for winter. Many processors, who dehydrate as well as can carrots, are interested in a supply of this crop to maintain their operations over as long a period as possible.

FERTILIZING FOR THE CROP

Carrots should receive plenty of potash and little or no nitrogen when grown on acid muck soils with a pH of 6.5 or less. Such soils, on warming in the late spring and early summer, increase in nitrogen content, often to rather high levels (100-300 pounds of nitrogen per acre). On the other hand, muck is naturally deficient in potash.

Table 1 shows the response during the past 10 years of this crop to various fertilizer ratios applied to an old, acid muck soil, 3 to 4 feet deep, well drained, and located at the State Muck Crops Experiment Farm near McGuffey, Ohio, in Hardin County. Evidence that potash is the most important single fertilizer element required for carrots on this muck was an 8.2 per cent increase in yield obtained from the use of 750 pounds per acre of a 3-9-0 fertilizer (carrying no potash) over the yield obtained when no fertilizer was used; whereas all the other fertilizer mixtures (second in each series, table 1) carrying potash resulted in an average increase in yield of 31.8 per cent, or 5.4 tons of topped carrots. Further evidence for the need of potash is shown by the results of the potash series. The increased yield obtained from 9 per cent of potash (135 pounds of muriate of potash) in the fertilizer was 14.1 per cent, or 2.6 tons of carrots, and a further increase of 8.6 per cent (1.8 tons) when another 9 per cent of potash was used. The increased yields from further applications of potash (table 1, last two plots in the potash series) were small. The usual fertilizer recommendation for carrots on muck is an 0-9-27 fertilizer, except on poorly drained alkaline or faintly acid muck (pH 6.7 or more) where a 3-9-18 ratio is suggested. The results at McGuffey do not show that an 0-9-27 ratio is much superior to an 0-9-18 fertilizer.

As shown by the nitrogen series (table 1), the response of carrots to this element, applied at the rate of 22.5 pounds of nitrogen per acre, is slight—an increase in yield of only 2.6 per cent or 0.6 tons—and indicates that little or no nitrogen need be applied for this crop on most musk soils (see exception above).

In the phosphate series, the moderate increase of 5.5 per cent (1.2 tons) secured from 9 per cent of phosphoric acid (337.5 pounds of 20 per cent superphosphate) over no phosphate and the still smaller increase of 3.5 per cent (0.8 tons) from an additional 9 per cent indicate that 9 per cent of phosphoric acid in the fertilizer is sufficient.

The amount of fertilizer usually applied for carrots is somewhere between 400 and 800 pounds per acre, broadcast. The last series of plots in table 1 compares the yields obtained by applying 750 pounds per acre of a 3-9-18 fer-

tilizer and a double application of 1500 pounds (750 pounds of a 6-18-36 mixture). The increase resulting from the double application is 10.3 per cent or 2.3 tons, which indicates there is an advantage in using more than 750 pounds per acre of a 3-9-18 mixture. Where the 0-9-27 ratio is used, 800 pounds per acre seems to have proved satisfactory. It is interesting to note that it would require 836 pounds per acre of an 0-8-28 fertilizer to replace the phosphate and potash which is removed in a 24-ton crop of carrot roots.

It is therefore recommended that at least 700 pounds of a fertilizer analyzing 0-8-24 or one near this ratio be used for carrots on muck soil. The exception is when up to 3 per cent nitrogen is included in fertilizer to be applied on very acid (pH 4.5 or below) or alkaline (pH 7.0 or above) mucks. The best method of application for carrots is in drills 7 inches apart and 3 to 4 inches deep; this varies from the earlier method of broadcasting the fertilizer.

The fact that the carrot is a strong "feeder" explains why it is able to remove much of the fertility from the soil and produce a fair to good yield without fertilization as long as the soil is fertilized before other crops in the rotation. For this reason, the muck should be well fertilized either before the carrot crop is planted or at least before the preceding crop in the rotation is planted.

TABLE 1.—The response of carrots on muck to various fertilizer ratios and amounts

Treatment, 10-year average yield and increase above the preceding treatment in each fertilizer series*

Treatment 750 pounds per acre	Yield per acre Tons	Increase in yield above preceding treatment	
		Tons	Per cent
Potash Series			
None	17.0	....	....
3-9-0	18.4	1.4	8.2
3-9-9	21.0	2.6	14.1
3-9-18	22.8	1.8	8.6
3-9-27	22.9	0.1	0.4
3-9-36	23.7	0.8	3.5
Nitrogen Series			
None	17.0	....	....
0-9-18	23.1	6.1	35.9
3-9-18	23.7	0.6	2.6
6-9-18	22.8	—0.9†	—3.8
9-9-18	22.6	—0.2	—0.9
Phosphate Series			
None	17.0	....	....
3- 0-18	21.7	4.7	27.7
3- 9-18	22.9	1.2	5.5
3-18-18	23.7	0.8	3.5
3-27-18	23.4	—0.3	—1.3
None	17.0	....	....
3- 9-18	22.4	5.4	31.8
6-18-36	24.7	2.3	10.3
3- 9-18	22.8‡	....	....

*Averages of four similarly treated plots from 1932 to 1941, inclusive.
†(—) Indicates a decrease in yield below the preceding treatment.
‡Ten-year average yield of all (5) standard-treatment (3-9-18) plots.

There is some evidence (1) that the yield, color, and sugar content of carrot roots will be improved by the application of copper sulfate (5 per cent of the fertilizer) on acid mucks (pH 6.5 or less) and manganese sulfate (15 per cent of the fertilizer) on alkaline mucks (pH 6.7 or more). Although several tests with these salts at McGuffey have shown inconsistent benefit for carrots, the cost is so reasonable that these applications are made as a matter of insurance that good crops will be produced.

PREPARATION OF THE MUCK AND PLANTING

Muck soils are loose and readily allow the normal development of the roots. Plowing 7 or 8 inches deep is advisable for this crop, followed by several harrowings if necessary to control weeds before the crop is planted. In very loose mucks compaction with a roller just previous to planting will insure the necessary moisture near the surface for the rapid germination of the seed.

The seeding of this crop begins as soon as the muck is in condition in the spring and may continue until the latter part of June. Provided there is ample moisture in the soil or irrigation water is available, plantings are sometimes made until the middle of July.

The earlier the seeding, the larger the size of the carrots. The early crops are usually superior to those planted later. For good-sized topped roots for storage or sale in the fall, 3 pounds of seed per acre is sown in May or June. For the early or bunching carrot crop 4 pounds of seed is used. The quantity of seed used will depend on row spacing. As little as 2 pounds is used where the rows are planted 30 to 36 inches apart to allow for horse cultivation. It is most common on muck to depend on hand or garden-tractor cultivation; the rows are then usually 16 to 24 inches apart, although some growers plant as close as 13 inches. Single-row hand or power multiple-gang drills are used in seeding with good results. On large acreages it is far more economical to use seed of high quality and known germination percentage and to set the drill for accurate spacing of the seed than to use cheaper seed and careless seeding and then follow up with a thinning operation. Carrot seeds are very delicate and grow slowly at first. Since so many things can happen to the carrot seedlings, it is sometimes necessary to use a slightly greater quantity of seed than is actually required to give the desired stand and then thin some if the resulting stand is too thick, due to very favorable growing conditions. It is usually safe on mucks to allow as many as 12 to 15 carrots to remain in each foot of row, since the roots will stand considerable crowding where they can expand by pushing away the light muck soil. Where the carrots are properly thinned, the individual roots will develop to a larger size, and approximately the same total yield will be secured.

The depth of planting will depend a great deal upon the condition of the muck and its moisture content. Shallow planting is always preferable to deep planting, especially when irrigation is available to hasten germination. The usual depth is one-half inch and adjustments up or down may be made from this depth to compensate for a dry or wet soil.

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(1) Harmer, P. M. 1941. The Muck Soils of Michigan. Mich. Agr. Exp. Sta. Spec. Bull. 314.

CARROT VARIETIES

According to the U. S. Department of Agriculture (2) between 85 and 95 per cent of all the orange-fleshed carrots sown in the United States were of the types represented by the varieties French Forcing, Scarlet Horn, Nantes, Red Core Chantenay, Danvers, Imperator, Long Orange, and Oxheart. It is very probable that four of these—Red Core Chantenay, Danvers, Nantes, and Imperator—meet practically all the demands of Ohio growers. The "bunching" variety has also come into prominence with Imperator for bunching purposes, especially in California.

In table 2 are given the results of a carrot variety test on muck at McGuffey, Ohio. The Nantes type, of which Nantes Coreless is one named variety, is highly recommended because of its excellent quality and earliness. The average Nantes tops and roots are too brittle for commercial bunching, although the Nantes Coreless variety in these trials compared favorably with the bunching strains and Imperator. The roots of Nantes are from 4½ to 6 inches long, nearly cylindrical, with blunt end. The flesh is deep orange in color and the core is of fine texture and flavor.

TABLE 2.—Comparison of carrot varieties and selections

Variety or selection	Number of roots in sample	Average weight per root	Top* breaking strength	Length,† average inches	Diameter‡ at top, av. inches	Diameter‡ at base, av. inches
		Ounces	*Pounds*			
Bunching No. 4	75	1.85	24.5	5.8	1.0	0.7
Bunching No. 5	100	1.39	7.1	5.7	0.9	0.8
Bunching Special	100	1.38	8.5	5.5	0.9	0.8
Imperator	78	1.60	23.9	5.7	1.0	0.7
Nantes Coreless	84	1.79	20.0	5.3	1.1	0.8
Chantenay	40	2.10	34.8	4.3	1.5	1.0
Red Cored Chantenay	38	2.52	32.2	4.6	1.5	1.0

*Straight pull in pounds to break top from root.
†Length of root from stem plate to base of fleshy root.
‡Top or "shoulder" diameter taken at point of greatest diameter. Bottom diameter taken at point of greatest diameter of stump end.

The Red Core Chantenay is the most widely used general- purpose variety. It is preferred for canning, dehydrating, and other manufacturing purposes, since it stores well, produces large yields, and is of good color and quality. This variety is midseason in maturity and the roots are from 4½ to 5½ inches long, tapering to a blunt end. It grows well under Ohio soil and climatic conditions and is still used for bunching by many growers.

Danvers is the most extensively used variety for bunching purposes, but it is also a good storage carrot. It is being supplanted by longer varieties of the Imperator type. It is midseason in maturity, with roots 5 to 6 inches long by 1¼ to 1¾ inches thick when in the bunching stage; the shape is tapering to a slightly rounded end; the flesh color is deep orange with a slightly yellow core.

The Imperator group includes the various "bunching" strains and all are extensively used for bunching. The Imperator is midseason to late in maturity. The roots are 6 to 7 inches long by 1 to 1⅝ inches thick, tapering only slightly to a short-tapered end. The shape and length of this type make attractive bunches of roots desired by the retail trade.

(2) Descriptions of Types of Principal American Varieties of Orange-Fleshed Carrots. 1940. U. S. D. A. Misc. Pub. 361.

The strain of carrot seed is of more importance than the variety, and growers should try several strains each year and thereby constantly improve the quantity and yield of their main crop, the seed of which is purchased by stock number the year following the trials.

IRRIGATION AND DRAINAGE

The carrot is quite tolerant of extremes of moisture in the soil, more so, for example, than potatoes. However, if the water table is held too near the surface for a considerable length of time the roots may grow with more or less of the crown out of the soil, which causes it to become discolored and the crop is less valuable. The same high water table can cause some branching of the roots. A muck near saturation will exclude air from the roots and cause the lenticels or breathing pores to enlarge and result in a very rough exterior. The proper depth to the water table should be from 24 to 36 inches.

TABLE 3.—Response of carrots on muck to irrigation

Average of four plots irrigated the same

	Water received by the crop in acre inches*	Yield per acre Tons	Increase in yield from added irrigation water†	
			Tons	Per cent
1936				
Rainfall only	4.28	24.4	....	....
Rainfall plus irrigation	14.57	33.7	9.3	38.1
	19.43	36.9	3.2	9.5
	29.14	36.6	—0.3	—0.8
1937				
Rainfall only	16.95	19.3	....	....
Rainfall plus irrigation	18.24	18.0	—1.3	—6.7
	20.32	17.4	—0.6	—3.3
	30.48	18.8	1.4	8.1
1938				
Rainfall only	15.18	15.8	....	....
Rainfall plus irrigation	18.75	18.0	2.2	13.9
	25.00	19.2	1.2	6.7
	37.50	16.3	—2.9	—15.1
1939				
Rainfall only	11.59	24.4	....	....
Rainfall plus irrigation	15.12	25.2	0.8	3.3
	20.16	19.9	—5.3	—21.0
	30.24	17.8	—2.1	—10.6

*One acre-inch is equivalent to 27,152 gallons.
†(—) Indicates a decrease in yield.

The response of this crop to irrigation is only moderate, but during periods of low rainfall and high evaporation profitable increases in yield may be obtained. In table 3 are given the yields obtained under rainfall alone and

with added irrigation water during several seasons. Details of the experiment, including method and time of application of water, are given elsewhere (3). During the exceptionally dry weather of 1936 the irrigation of carrots proved very profitable. Only slight or moderate increases in yields were obtained during the other seasons when total rainfall was normal. Provided the irrigation system was installed for use on other crops in a rotation, there would undoubtedly be times during the growing period of the carrot crop when the application of water would prove profitable. This is indicated by the smaller increases in yield from irrigation obtained during 1938 and 1939.

LABOR AND RETURNS

The Ohio state average yield of late carrots per acre during 1930-1939 was 510 bushels of 50 pounds each (4). The man hours per acre required for preharvest were 85 and for harvest were 250, making a total of 335 man hours of labor to produce this crop. These figures compare closely with figures from California, where the cultural labor for bunch carrots for market was 88 man hours per acre; harvesting labor, 166 hours; and packing and shed work, 39—making a total of 293 man hours for the average state yield per acre of 28,000 pounds.

The average yield per acre of topped carrots from muck soil will be between 10 and 15 tons, with yields varying from 5 to 20 tons. A survey made in Indiana during 1932 showed that canners purchased most of the carrots at from $5 to $12 per ton, depending upon whether they were sold at the farm or delivered to the cannery. Wholesale produce dealers paid an average of $8 per ton delivered, and retail grocers paid an average of $17 per ton delivered to the stores.

The purpose of this article has been to draw the attention of those vegetable growers in Ohio who are favorably situated for the production and marketing of carrots to the fact that the demand for this crop remains strong and at least some 400 bushels per acre of late carrots worth 60 cents per bushel should be realized on the muck soils of the State. The return per man hour of labor is thus approximately 80 cents, which compares very favorably with that secured from many other vegetable crops.

(3) Comin, D., and J. D. Wilson. 1941. The Use of an Evaporation Index in Timing the Irrigation of Muck Crops. Ohio Agr. Exp. Sta. Bimon. Bull. 26 (209).

(4) Cooper, M. R., et al. Labor Requirements for Crops and Livestock. 1943. U. S. D. A. Bur. of Agr. Econ. F. M. 40.

THE EFFECT OF STRAW MULCH, CULTIVATION, AND NITROGEN FERTILIZER ON THE GROWTH AND YIELD OF LATHAM RASPBERRIES

WESLEY P. JUDKINS[1]

Straw mulch has been recommended (1, 2, 3) over clean cultivation as a cultural treatment for raspberries because it conserves soil moisture, prevents erosion, and increases the yield of berries. Also, the soil temperature is lower in summer under a straw mulch. This is an important consideration in the southern part of the raspberry-growing region.

A number of workers (4, 5, 6) also have shown that nitrogen fertilizer increases the productivity of red and black raspberries.

The experiments being reported herein were designed to secure additional information on the effect of straw mulch and cultivation on the growth and yield of red raspberries and to determine the value of nitrogen fertilizer when used with these cultural treatments.

PROCEDURE

In the spring of 1936 eight rows of Latham red raspberry plants were set in Wooster silt loam soil. Each row was 270 feet long. Until the fall of 1938 the entire planting was handled under a system of summer cultivation, followed by a winter cover crop of rye.

In the fall of 1938 a straw-mulch treatment was started. At this time the northern half of each row of plants was completely mulched with wheat straw at the rate of 10 tons per acre. About 2 tons of straw per acre were applied over the entire northern half of the area occupied by the raspberry plantation each succeeding fall in order to suppress the growth of grass and weeds. The southern half of the planting was continued under the original cultivation-cover crop treatment.

In the spring of 1939 and of 1940 four of the eight rows were fertilized with ammonium sulfate fertilizer, the mulched portions receiving 500 pounds per acre and the cultivated portions 250 pounds per acre. The four remaining rows received no fertilizer.

The yield of berries from each treatment was recorded each year. The canes were counted in each row in 1940 and 1941 and their diameter determined as soon as the crop had been harvested.

[1]This work was under the direction of A. L. Havis from 1936 to 1942.

1. Baker, C. E. 1933. Raspberries and Blackberries. Ind. (Purdue) Ext. Bull. 191.
2. Clark, J. Harold. 1937. Culture and Handling of Raspberries. Proc. Md. Hort. Soc. 39th An. Mtg.: 63-70.
3. Havis, Leon. 1937. Results of Mulching Black Raspberries. Ohio Agr. Exp. Sta. Bimo. Bull. 22 (184): 18-20.
4. Collison, R. C., and G. L. Slate. 1943. Black Raspberries Respond to Nitrogen Fertilizers. N. Y. Agr. Exp. Sta. Farm Res. **IX** (3): 3, 14.
5. Holland, C. S. 1927. Fertilizer for Raspberries. Ohio Stockman and Farmer.
6. Shoemaker, J. S. 1934. Responses from the Use of Nitrogen Fertilizer on Red Raspberries. Ohio Agr. Exp. Sta. Bimo. Bull. **19** (168): 97-103.

RESULTS

As shown by the data of tables 1 and 2, the nitrogen fertilizer applied in 1939 and 1940 increased the yield of raspberries in 1940 and 1941. It is evident that the increased production was due to the fertilizer, since the portion of the plots which was to receive the fertilizer produced less fruit in 1939 than did the portion which was to remain unfertilized. Also, when the fertilizer application was discontinued the yield of the fertilized plots dropped back to the approximate level of the unfertilized portion.

TABLE 1.—Effect of nitrogen fertilizer on growth and yield of cultivated Latham raspberries

	Unfertilized	Fertilized in spring 1939 and 1940 with 250 lb. per acre of ammonium sulfate	Gain of fertilized over unfertilized plots*	Per cent gain of fertilized over unfertilized plots*
	1939			
Yield per acre, pints	7,843	7,618	—225	—2.9
	1940			
Yield per acre, pints	5,298	5,603	305	5.8
Canes per acre	12,694	14,114	1,420	11.2
Average cane diameter, millimeters	7.1	7.9	0.8	....
Yield per cane, pints	0.43	0.40	—0.03	....
	1941			
Yield per acre, pints	2,623	3,072	449	17.1
Canes per acre	8,068	8,499	431	5.3
Average cane diameter, millimeters	7.8	7.8	0.0	....
Yield per cane, pints	0.34	0.35	0.01	....
	1942			
Yield per acre, pints	2,866	3,010	144	5.0
	1943			
Yield per acre, pints	341	350	9	2.6

* (—) represents loss.

The average cost of ammonium sulfate fertilizer was $38.00 a ton, or $1.90 per 100 pounds. If the value of the berries is calculated at $.10 per pint, the expenditure of $4.75 for fertilizer on the cultivated plots returned $30.50 in 1940 and $44.90 in 1941. In the straw-mulched plots the fertilizer cost $9.50 per year and returned $265.80 in 1940 and $145.30 in 1941. Such returns show the actual economic value of using nitrogen fertilizer for raspberries under the conditions which existed in the experiments reported here.

Raspberry plants mulched with wheat straw yielded more berries than similar plants under a system of cultivation and cover crops. Tables 1 and 2 show yields of these cultural treatments for the fertilized and unfertilized plots, while table 3 gives the average of all plots under mulch and cultivation. The use of straw mulch increased the yield (1939 to 1942) by 1570 to 2950 pints per acre, or by 38 to 69 per cent, compared to unmulched plants.

The yields for 1943 are of minor significance because the planting was badly depleted. The use of mulch without fertilizer increased the value of the harvested crop by $107.70 in 1940 and by $147.00 in 1941. The use of mulch and fertilizer increased the value of the crop $343.00 in 1940 and $247.40 in 1941. The average increase in value per acre of all mulched over all cultivated plots from 1939 to 1942 was $157.20 to $294.90.

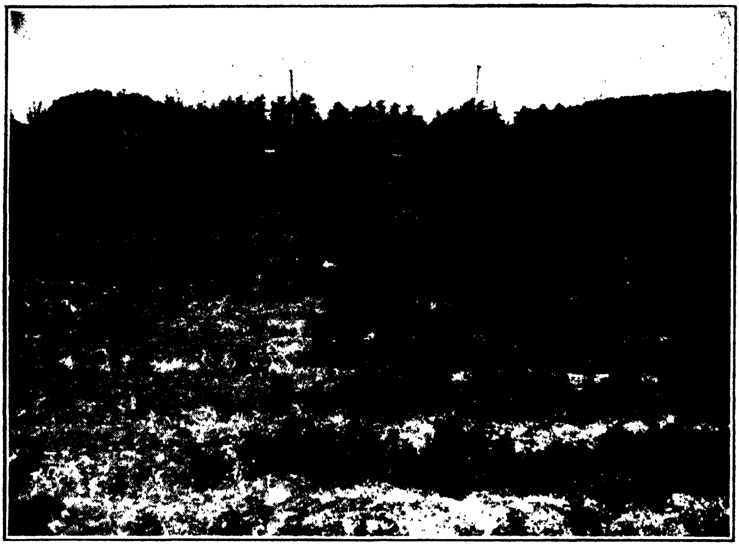

Fig. 1.—Latham raspberry planting: cultivated section at left, mulched section at right. The depletion of the cultivated portion of the planting is due to winter heaving of the plants and to a generally lower vigor than plants of the mulched area.

Several workers (7,8) have stated that large, vigorous canes are necessary to produce heavy crops of raspberries. The data presented in tables 1, 2, and 3 indicate that in the present tests with average cane diameters of 7.1 to 8.2 millimeters, the size of canes did not significantly influence yields. The number of canes per acre and their general vigor (other than diameter) were important in determining yield. This observation agrees with the work of Teske and Gardner (9) who emphasize the importance of a large number of fruiting canes per acre if high yields are to be secured.

One of the important effects of mulch on the growth of raspberry plants is illustrated in figure 1. This picture was taken in 1943 and shows the very poor stand of plants in the cultivated portion of the raspberry planting. Winter heaving was a serious problem in this experiment and was largely responsible for the small number of plants in the cultivated part of the plant-

7. Johnston, Stanley. 1925. Winter Pruning of the Black Raspberry. Mich. Agr. Exp. Sta. Spec. Bull. 143.

8. Shoemaker, J. S., C. W. Bennett, and J. S. Houser. 1930. Raspberries and Blackberries in Ohio. Ohio Agr. Exp. Sta. Bull. 454.

9. Teske, A. H., and V. R. Gardner. 1927. Management Methods in the Raspberry Plantation. Mich. Agr. Exp. Sta. Spec. Bull. 165.

ing at the end of the experiment. Figure 2 is a closer view of a raspberry plant which has been heaved from the soil as a result of alternate freezing and thawing during late winter and spring.

Fig. 2.—Latham raspberry plants heaved from the ground in a cultivated plot on Wooster silt loam soil.

TABLE 2.—Effect of nitrogen fertilizer on growth and yield of Latham raspberries mulched with straw

	Unfertilized	Fertilized in spring 1939 and 1940 with 500 lb. per acre of ammonium sulfate	Gain of fertilized over unfertilized plots* Pints	Gain of fertilized over unfertilized plots* Per cent
	1939			
Yield per acre, pints	10,837	10,522	—315	—2.9
	1940			
Yield per acre, pints	6,375	9,033	2,658	41.7
Canes per acre	18,466	22,256	3,790	20.5
Average cane diameter, millimeters	7.2	8.2	1.0	.....
Yield per cane, pints	0.35	0.41	0.06	.....
	1941			
Yield per acre, pints	4,093	5,546	1,453	35.5
Canes per acre	11,310	16,117	4,807	42.5
Average cane diameter, millimeters	7.6	8.0	0.4	.....
Yield per cane, pints	0.36	0.34	—0.02	.....
	1942			
Yield per acre, pints	4,517	4,504	—13	—0.3
	1943			
Yield per acre, pints	969	1,126	157	16.2

*(—) represents loss.

TABLE 3.—Comparison of cultivation and straw mulch as cultural treatments for Latham raspberries

	Cultivated plots	Mulched plots	Gain of mulched over cultivated plots* Pints	Gain of mulched over cultivated plots Per cent
		1939		
Yield per acre, pints	7,731	10,680	2,949	38.1
		1940		
Yield per acre, pints	5,450	7,804	2,354	43.2
Canes per acre	13,404	20,361	6,957	51.9
Average cane diameter, millimeters	7.5	7.7	0.2	....
Yield per cane, pints	0.41	0.39	—0.02	....
		1941		
Yield per acre, pints	2,849	4,819	1,970	69.1
Canes per acre	8,283	13,713	5,430	65.6
Average cane diameter, millimeters	7.8	7.8	0.0	....
Yield per cane, pints	0.34	0.35	0.01	....
		1942		
Yield per acre, pints	2,938	4,510	1,572	53.5
		1943		
Yield per acre, pints	346	1,047	701	202.6

*(—) represents loss.

SUMMARY AND CONCLUSIONS

Nitrogen fertilizer increased the yield of Latham raspberries grown under cultivation and cover crop or mulch treatments on Wooster silt loam soil. On well drained soils of moderate fertility an annual spring application of 200 to 300 pounds of ammonium sulfate, or its equivalent, should give profitable increases in yield of raspberries.

The use of straw mulch is probably the best cultural treatment which can be followed for raspberries. An important limiting factor in this system may be the lack of mulch material at a price which can be considered economically satisfactory to the berry grower. The principal advantages of a mulch system compared to cultivation are:

1. Higher yields of berries.
2. Conservation of soil moisture.
3. Prevention of erosion.
4. Control of weeds.
5. More vigorous cane growth.
6. Reduced heaving of plants which results from freezing and thawing of soil in late winter and spring.
7. Lower and more uniform soil temperature in summer. This is particularly important in the southern part of the raspberry growing region.

CULTURE STUDIES OF THE DRUG PLANT *ATROPA BELLADONNA*

W. R. BREWER AND ALEX LAURIE

A federal cooperative project established in January 1942 by the Ohio Agricultural Experiment Station and the Colleges of Pharmacy and Veterinary Medicine of the Ohio State University was continued through 1943 in further search for information needed for the culture of certain medicinal plants, the imports of which have been curtailed by war activities.

Atropa belladonna, a member of the Solanaceae family native to central and southern Europe and Asia Minor, was selected for initial study early in the investigation. This report follows the discussion of the 1942 progress published early in 1943 (1).

EXPERIMENTAL STUDIES

GERMINATION

In a germination study utilizing 15 different combinations of soil media and watering methods, the highest germination percentages of Belladonna seed obtained ranged from 40 to 48 per cent. The highest rate of germination took place in sand and peat mixtures, which were watered by subirrigation with two wicks or by overhead watering and then were subsequently covered with glass to maintain uniform high moisture. To increase this percentage of germination, the seeds were soaked in water, sulfuric acid, and hydrochloric acid, stored at cold temperatures prior to planting, stored at high temperature and humidity, alternately heated and cooled in germination media, and planted in soil maintained at a temperature of 90 degrees Fahrenheit. From these tests it was found that a uniform germination of 95 to 100 per cent resulted from the following combination of treatments: (a) immersion for from 60 to 100 seconds in commercial sulfuric acid to weaken seed coats; (b) soaking in water for 24 hours to break dormancy; (c) planting in sandy loam soil; (d) maintaining the flats at a temperature of 90 degrees Fahrenheit for the first week; (e) utilizing overhead watering, and covering with a sheet of glass to maintain high moisture.

1. Stillings, E. N., and Alex Laurie. 1943. Culture studies of the drug plant *Atropa belladonna*. Ohio Agr. Exp. Sta. Bimon. Bull. 28 (221): 64-74.

TABLE 1.—Belladonna production and assays for 1942 and 1943
(Correlation table for nutrition and pH variations)

High Nitrogen				Low Nitrogen				High Phosphorus				Low Phophorus			
1942		1943		1942		1942		1942		1943		1942		1943	
Prod.	Assay*	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay
Lb. 1855	*Pct.* 0.31	*Lb.* 1644	*Pct.* 0.44	*Lb.* 1311	*Pct.* 0.33	*Lb.* 1193	*Pct.* 0.46	*Lb.* 1685	*Pct.* 0.30	*Lb.* 1405	*Pct.* 0.45	*Lb.* 1507	*Pct.* 0.34	*Lb.* 1462	*Pct.* 0.44

*Assay=Percentage of alkaloids.

TABLE 1.—Belladonna production and assays for 1942 and 1943—Continued
(Correlation table for nutrition and pH variations)

High Potash				Low Potash				pH7				pH6				Check			
1942		1943		1942		1943		1942		1943		1942		1943		1942		1943	
Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay
Lb. 1599	*Pct.* 0.31	*Lb.* 1375	*Pct.* 0.44	*Lb.* 1520	*Pct.* 0.33	*Lb.* 1421	*Pct.* 0.45	*Lb.* 1719	*Pct.* 0.33	*Lb.* 1351	*Pct.* 0.44	*Lb.* 1795	*Pct.* 0.38	*Lb.* 1484	*Pct.* 0.45	*Lb.* 1580	*Pct.* 0.31	*Lb.* 1182	*Pct.* 0.44

TABLE 2.—Composite of production and assays for 1942 and 1943

(Correlation table for nutrition and pH variations)

High Nitrogen		Low Nitrogen		High Phosphorus		Low Phosphorus		High Potash		Low Potash		pH7		pH6		Check	
Prod.	Assay*	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay	Prod.	Assay
Lb. 1749	*Pct.* 0.38	*Lb.* 1252	*Pct.* 0.40	*Lb.* 1545	*Pct.* 0.38	*Lb.* 1484	*Pct.* 0.39	*Lb.* 1487	*Pct.* 0.38	*Lb.* 1470	*Pct.* 0.39	*Lb.* 1535	*Pct.* 0.39	*Lb.* 1639	*Pct.* 0.42	*Lb.* 1381	*Pct.* 0.38

*Assay=Percentage of alkaloids.

NUTRITION

For confirmation of the 1942 work, nutrition plots were multiplied fourfold. Eight different nutritional combinations varying the concentrations of nitrogen, phosphorus, and potassium were maintained in soil with a pH of 6.5 to 7.5 and in soil with a pH of 5.5 to 6.5. Sixteen of the plots contained 2-year-old plants yielding four harvests, and 48 plots contained first-year plants yielding three harvests. The crops were cured on racks in a dry, well ventilated, darkened room. Dry weights were obtained for production figures, and the material was ground and assayed for determination of alkaloid yields. Production figures and alkaloid assays were correlated with each pH and nutritional variation. These correlations for both 1942 and 1943 crops appear in table 1. Production figures throughout this report are in pounds of dry weight per acre unless stated otherwise (12″ × 12″ planting), and the assay figures are in percentage of alkaloids as determined by the United States Pharmacopoeia method of assay. The concentration of nutrients are: high nitrogen, 50-100 parts per million; low nitrogen, 10-50 parts per million; high potassium, 20-40 parts per million; low potassium, 5-20 parts per million; high phosphorus, 5-10 parts per million; low phosphorus, 1-3 parts per million.

In both years high soil-nitrogen levels resulted in greater weight production than low nitrogen. The low pH plots produced higher yields for both years. Lack of uniformity in results of phosphorus and potassium studies over the 2 years, combined with the fact that low applications produce yields in excess of the check plots, indicate that only low levels of these elements are necessary for optimum production. These results may be seen more clearly in a composite of the 2 years' results, as shown in table 2.

TIME OF FERTILIZER APPLICATION

Due to the fact that the nitrogenous constituents of certain field crops are increased more upon the additions of fertilizers at late stages of growth than at early stages, Belladonna plots were enriched with ammonium sulfate at the rate of 4 pounds per 100 square feet at three stages of development—premature, flowering, and fruiting—in an attempt to increase the alkaloidal content. The comparison of alkaloid yields of these plants with a check plot is found in table 3.

TABLE 3.—Belladonna assays of whole plants grown in plots nitrated at three stages of growth

Treatment	Alkaloidal assays
	Per cent
Check plots	0.31
Soil nitrated at premature stage	0.37
Soil nitrated at flowering stage	0.22
Soil nitrated at fruiting stage	0.30

These data indicate that Belladonna plots should be fertilized soon after establishment of the plants.

COLCHICINE APPLICATIONS

In 1942 a series of Belladonna seedlings were treated with colchicine by immersion in solutions of varying concentrations for varying periods of time or by applying a 1 per cent lanolin paste or a 1 per cent spray to the growing tips. These plants were carried through the season, seed were collected, and the seeds were planted in 1943. The production of the 1943 plants appears in table 4.

TABLE 4.—Production and assays of plants grown from seed collected from colchicine-treated mother plants

Treatment	Production	Assays
	Pounds	*Per cent*
Seedling immersion, .3% solution, 6 hours	1359	0.46
Seedling immersion, .3% solution, 4 hours	1032	0.36
Seedling immersion, .2% solution, 4 hours	1515	0.34
On growing tips, 1% lanolin paste	1302	0.27
On growing tips, 1% aqueous spray	1630	0.43
Check plots	2126	0.44

One year's trials indicate little effect of colchicine on the percentage of alkaloids and show a definite decrease in yield.

PLANT HARDENING PRIOR TO PLANTING

When seedling plants are maintained in the greenhouse for a long period of time while awaiting proper planting weather, they often become spindly and weak. To determine the results in production of these weakened plants as compared with plants hardened before planting, some plants were pinched back at the growing tips and maintained in cooler surroundings. Table 5 indicates that the toughening of plants accustoms them to the cold weather of early planting.

TABLE 5.—Belladonna production after varied pre-planting treatments

Treatment	Temperature	Grams per plant	Pounds per acre
Greenhouse check (no hardening)	65° F.	25.9	2126
Pinched back in greenhouse	65° F.	24.9	2044
Pinched back in cold frame	45° F.	38.2	3142

Hardening of plants prior to planting is conducive to quicker establishment in the field and greater yield.

TIME OF HARVEST

As no previous work showed a basis for harvesting Belladonna at any particular time, an investigation was carried out to determine the stage of development at which the highest alkaloidal yields could be expected. Results of this study appear in table 6.

TABLE 6.—Belladonna assays of plants harvested at three different stages of development

Time of harvest	Alkaloid yield
	Per cent
Harvested before maturity	0.31
Harvested at flowering time	0.34
Harvested at fruiting time	0.29

From this composite of numerous assays it is apparent that the highest yield of alkaloids may be expected when the harvest is carried on during the flowering period.

ALKALOID LOCATION

In harvesting Belladonna a cut is made about 5 or 8 inches above the ground, leaving several leaves intact to carry the plants through to the next period of growth and subsequent harvest. As the plants begin to develop again, these leaves frequently attain the size of a man's hand and are conspicuous among the small leaves and growing tips. To determine whether the large or small leaves are higher in alkaloid content, a number of plants in different locations and at different ages were stripped of both types of foliage. The averages of all these assays for the two types appear in table 7.

TABLE 7.—Averaged Belladonna assays of large, mature leaves and young actively growing leaves and tips

Old mature leaves	Young leaves and tips
Per cent	*Per cent*
0.266	0.381

The results shown in table 7 indicate that immature foliage has a greater alkaloid content.

POST HARVEST ALKALOID RE-LOCATION

For many years herbalists and herbal publications have advocated the curing of medicinal plants by suspending them in dry sheds from cords tied around the stems or roots. In the 1942 studies, Belladonna plants were cured at first by separating the fresh leaves from the stems and curing the two parts on trays. Later, due to shortage of labor, plants were cut near their bases and the entire plants impaled on nails driven through long racks. In this way, the plants were cured hanging upside down and the leaves were stripped from the stems after drying. When the assays of these various products were compared, there was an indication that when whole plants were hung up to cure there was a passage of alkaloids from the stems into the leaves. In order to confirm these results further investigations were developed in 1943. Plant material collected from 2-year-old plants in 1942 was assayed with the results shown in tables 8 and 9.

TABLE 8.—Post-harvest alkaloid re-location in 2-year-old plants

Leaves and stems separated and cured on trays		Whole plants cured on racks before separation	
	Per cent		*Per cent*
Alkaloids located in stems	52	Alkaloids located in stems	48
Alkaloids located in leaves	48	Alkaloids located in leaves	52

Since the roots of Belladonna have been known to contain more alkaloids than other portions of the plant, it was thought that this high content could be transferred to the leaves by hanging the whole plant, including the roots, from racks as indicated. Consequently, plots of Belladonna were harvested and the plants cured in the two manners described before. See table 9.

TABLE 9.—Post-harvest alkaloid re-location in one-year-old plants cured with roots intact

Plant parts separated and cured on trays		Whole plants cured on racks before separation	
	Per cent		*Per cent*
Alkaloids located in roots	50	Alkaloids located in roots	47
Alkaloids located in stems	16	Alkaloids located in stems	17
Alkaloids located in leaves	34	Alkaloids located in leaves	36

A study of the same type was carried on with plants in three different stages of development. Only stems and leaves were included, as may be seen in table 10.

TABLE 10.—Post-harvest alkaloid re-location in plants of varying stages of development

Developmental stage of plants	Parts cured separately		Whole plant cured before separation	
		Per cent		*Per cent*
Immature	Stems	55	Stems	57
	Leaves	45	Leaves	43
Flowering	Stems	54	Stems	51
	Leaves	46	Leaves	49
Fruiting	Stems	51	Stems	43
	Leaves	49	Leaves	57

It appears that the post-harvest mobility of alkaloids increases with increasing age of the plants.

Two explanations seemed possible for the phenomenon of alkaloid re-location in plants hanging upside down: one, that some physiological process was tending to draw the alkaloids down into the leaves; and the other, that the movement was an effect of gravity. To determine the value of this latter explanation, plants were cured while being maintained in an upright position. If the effect were due to gravity, the alkaloids should have moved into the roots. The results appear in table 11.

TABLE 11.—Post-harvest alkaloid re-location in plants cured in an upright position

Plants cured separately on trays		Whole plants cured upright before separation	
	Per cent		*Per cent*
Alkaloids located in roots	50	Alkaloids located in roots	35
Alkaloids located in stems	16	Alkaloids located in stems	22
Alkaloids located in leaves	34	Alkaloids located in leaves	43

To establish alkaloid movement positively a special test was devised utilizing only one set of plants; thus the confusing factor of natural variation in alkaloidal content of different sets of plants was eliminated. One-half the leaves of a group of plants was stripped off while fresh and then cured on trays; whereas, the other half was left to cure on the plants while hanging from racks. The assays of these two sets of leaves appear in table 12.

TABLE 12.—Post-harvest alkaloid re-location into intact leaves as compared with fresh stripped leaves of the same plants

One-half of leaves stripped fresh and cured on trays		One-half of leaves cured on plants hanging from racks	
	Per cent		*Per cent*
Alkaloids	0.27	Alkaloids	0.39

When mature plants are cured whole, regardless of upright or inverted position, the quantity of alkaloids in the roots is diminished and the quantity in the foliage is increased. If the roots are removed, the alkaloid ordinarily present in the stems is shifted to the leaves.

MULCHING

With the thought that it was desirable to carry plants through the winter in order to take advantage of the higher alkaloid yields of 2- and 3-year-old specimens, heavy, medium, and light mulches were applied to light loam and to heavy soil plots in December 1942. In the spring of 1943 these plots were checked for survivals. The results appear in table 13.

TABLE 13.—Mulching and winter survival of Belladonna plants

	Survival
	Per cent
Silt loam plots:	
Heavy mulch (12 inches strawy manure)	75
Medium mulch (6-8 inches strawy manure)	60
Light mulch (3-4 inches strawy manure)	57
No mulch	9
Heavy soil plots:	
Heavy losses in unmulched and heavily mulched plots.	
Medium mulch best.	

Correlation of the winter survivals of equally mulched plots maintained under varying nutritional levels resulted in the information appearing in table 14.

TABLE 14.—Correlation of winter survival with nutrition levels

	Survival
	Per cent
High-nitrogen plots	64
Low-nitrogen plots	84

It appears that reduction of the nitrogen level of the soil toward the end of the growing season is conducive to greater winter survival. Variations found with other elements were insignificant.

SUMMARY

1. **Germination.** To secure high germination immerse seeds for 60-100 seconds in commercial sulfuric acid, soak in water for 24 hours, and sow in sandy medium. Maintain a temperature of 90° F. for one week, then reduce to 60° F.

2. **Nutrition.** High nitrogen levels increase production. Low levels of phosphorus and potassium are satisfactory. A pH of 5.5 to 5.6 is most satisfactory.

3. **Time of fertilizer application.** To secure higher assays nitrates should be applied in the vegetative stage.

4. **Colchicine** proved ineffective.

5. **Hardening** of plants prior to planting is conducive to quicker establishment in the field and to higher yields.

6. **The highest** assays are secured when **harvesting** takes place during the flowering period.

7. Alkaloids are greater in immature foliage.

8. **Alkaloid re-location.** When mature plants are cured whole, regardless of upright or inverted position, the quantity of alkaloids in the roots is diminished and the quantity in the foliage is increased. If the roots are removed, the alkaloid ordinarily present in the stems is shifted to the leaves.

9. **Mulching.** In light soils a heavy mulch is conducive to overwinter survival. In heavy soils a medium mulch is indicated. Winter survival may also be increased by reduction of the soil nitrogen level to 10-50 p. p. m. toward the end of the growing season.

THE APPLE MAGGOT

C. R. CUTRIGHT AND T. H. PARKS[1]

The season of 1943 witnessed the most serious outbreak of the apple maggot that northern Ohio has ever experienced. Not only was this pest much more injurious in the areas where it had been previously reported, but it also extended its range to the west and south. It was found in injurious numbers as far south as Guernsey, Licking, Franklin, and Montgomery Counties. Numerous complaints of injury were received from northwestern Ohio. In addition, the insect, in noninjurious numbers, was collected by entomologists in Gallia and Lawrence Counties. Thus, it appears that the apple maggot is now to be found in all the principal apple-growing sections of Ohio.

The apple maggot is native to North America. The geographic range in which it is an important pest is limited quite largely to the New England area and to the states surrounding the Great Lakes. In Canada, the maritime provinces, together with Quebec and Ontario, are infested. The original food plants were wild crab apple and various wild hawthorns. In Ohio, the pest was first collected by entomologists in 1925; losses, however, were first reported by growers to the Extension Service in 1929. Since these dates, reports of injury have been received every year. Northeastern Ohio has been, and still is, the area of heaviest infestation.

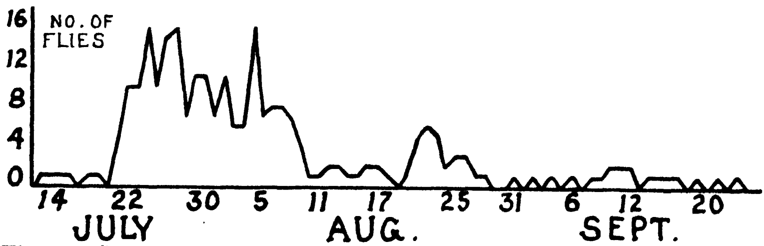

Fig. 1.—Graph showing typical emergence curve of apple maggot flies in northern Ohio. Data collected by R. W. Dean.

The apple maggot is principally a pest of home orchards and of fruit grown on trees that receive only a light, summer arsenical spray schedule. The principal varieties of apples infested in Ohio are: Transparent, Wealthy, Grimes, Jonathan, Belmont, and Talmon Sweet; and sometimes Twenty Ounce, Baldwin, and Northern Spy. No variety is immune. Because of the insidious nature of its work, apple maggot injury is often overlooked in the early stages and many infested apples may be marketed after grading, only to have them returned by the consumer who finds them tunneled beyond salvaging. As the apple becomes mellow, or after it drops, the full effect of the injury becomes apparent. Most of the badly infested fruits drop prematurely and, as they lie on the ground, they serve as especially favorable breeding quarters for the maggots.

[1]Authors' names are in alphabetical order.

In apple varieties ripening in August and September open tunnels occur throughout the flesh and under the skin, where the trail of the larva may be distinctly visible. This gives the insect the often assigned, but poorly descriptive, name of "railroad worm." The open tunnels in the flesh of late-summer or early-fall varieties soon develop rot and the fruits quickly decay.

Fig. 2.—Trails beneath the skin of the apple and exit hole of the larvae of the apple maggot.

In late-maturing varieties the damaged fruits are frequently difficult to detect. The outward appearance may be normal, but the flesh contains small corky spots and discolored trails or streaks. In instances of mild attack the surface of the infested apple may show but little indication of the damaged condition of the fruit except for the shallow "pin point dimples" which mark the spots where the cuticle was slit to insert an egg beneath the surface. If the infestation is severe, these egg-laying punctures may be so numerous that they alone will malform and ruin the fruit. Most maggots infesting winter varieties die before maturing, but they may leave their brown, threadlike trails through the flesh of the fruit. The larvae which mature in early varieties, and the few which succeed in becoming full grown in late-maturing apples, remain in the fallen fruits only a short time before emerging to enter the soil.

LIFE HISTORY

The adult of the apple maggot is a strikingly marked fly. The female is about the size of the ordinary house fly, but the male is slightly smaller. Both male and female carry a distinct black mark in the shape of the letter "z" on each wing. While resting, the wings are held horizontal and the markings are then easily seen.

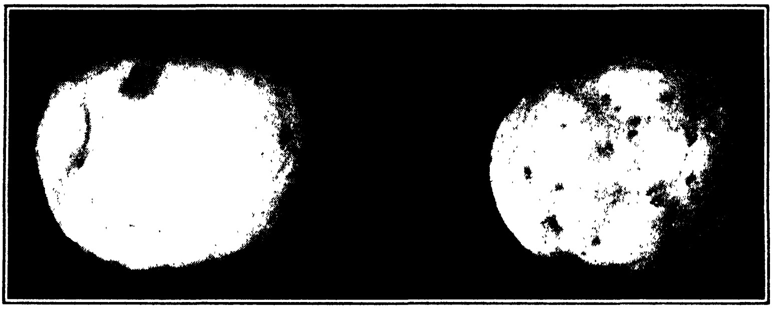

Fig. 3.—Apples malformed by egg punctures of the female maggot fly.

The first flies may emerge from the soil as early as July 4, but the largest numbers appear during the last 2 weeks in July and the first week in August. At Wooster, usually emergence is over by August 25, but in Lake County flies have emerged after the middle of September (see figure 1). In the northern Ohio orchards, flies have been seen as early as July 7 and as late as September. If the orchard is heavily infested the flies are not hard to find, especially in late July and early August.

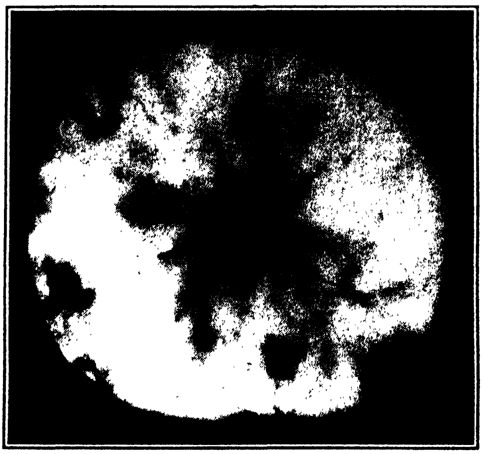

Fig. 4.—Apple cut in half to show trails of the maggot larvae through the flesh of the fruit.

After emerging from the soil, the female fly spends a feeding period of from *7 to 10 days before laying the first egg.* During this period, she feeds by lapping up moisture from the surfaces of the foliage and fruit. This habit

is the key to our most successful means of control, which will be discussed later. At the completion of this early feeding period, during which eggs mature in the body of the female, she cuts a tiny slit in the skin of the fruit and deposits her egg therein. Ripening fruits are preferred for egg laying. The eggs hatch in a relatively short time and, if the young larva finds itself in a fruit that is maturing, rapid feeding and growth ensue. However, if the fruit is still "green", feeding and growth are very slow and many larvae die. In apple varieties such as Early Harvest, the larvae will have matured and left the fruit as early as August 10. In some of the late varieties, such as Stayman, larvae seldom mature, if temperatures are low. Infested fruits of late varieties, taken from common storage, have produced mature larvae as late as December 1. In the orchard, larvae which leave the fruit enter the soil at once and form puparia just beneath the surface. Some larvae may spend over 10 months in this position before emerging as adult flies the following summer. Others have been known to spend 22 months, or nearly 2 years, in the soil before emerging.

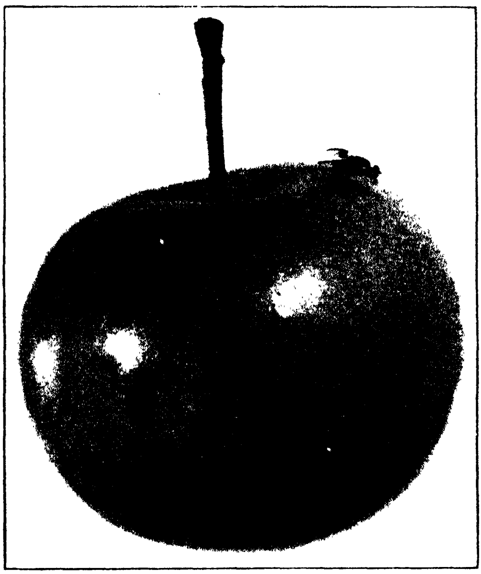

Fig. 5.—Adult flies of the apple maggot resting on apple fruit: (courtesy of the Connecticut Agricultural Experiment Station, New Haven, Conn.)

CONTROL

As already stated, 7 to 10 days are spent in feeding before the adult flies deposit their eggs. Food is secured by lapping up moisture from the surfaces of the foliage and fruit. Therefore, if such surfaces are covered with a poison soluble in moisture, the flies will be killed before they can harm the fruit.

Spraying.—The apple maggot never bothers in orchards where numerous spray applications of arsenicals are used for the control of the codling moth.

In less thoroughly sprayed orchards, special apple maggot sprays are necessary. For all practical purposes the first maggot spray for northern Ohio should be applied about July 10 to 15 to kill the early emerging flies, this spray should be repeated about 3 weeks later (July 30 to August 5) for late emerging flies. Three arsenical sprays might be needed in unusual cases. Either lead arsenate or calcium arsenate is satisfactory. The purpose is to cover the surfaces of the leaves and fruit with fine particles of the poison so that the fly will lap up some of the insecticide while feeding. Three pounds of arsenical per 100 gallons of water with the regular amount of lime, or zinc sulfate and lime, are recommended. If necessary a sulfur fungicide may be included. The second of these sprays coincides with the regular second-brood codling-moth spray, so only one extra spray is required in most orchards. Dust applications of arsenicals are satisfactory for apple maggot control, but rains may wash off the poison and make it necessary to use more applications than required for sprays.

Sprays of Phenothiazine and dusts containing rotenone are the only non-arsenical insecticides known to be effective against the apple maggot. Due to cost and wartime restrictions, these are not considered practical at the present time.

It is a mistake to apply the maggot sprays only to the trees that were infested the previous season. Some flies will remain on the unsprayed trees until their eggs are mature and then fly to the sprayed trees, where they will lay eggs before feeding. The purpose of the spray is to kill the flies before they are ready to lay eggs and this is accomplished only by spraying the non-bearing, as well as the bearing, trees. After the eggs are placed beneath the skin of the apple it is impossible to control the pest. The fact that flies move from tree to tree makes control on backyard trees very difficult.

Supplemental controls.—Picking up fallen apples and burying them or making them into cider contributes something to control. The fallen fruits should be gathered each day or every second day before the maggots can leave the fallen fruits and enter the soil. This method can be easily used in the backyard planting but perfect control is never achieved by it alone. This method is not practical for commercial orchards.

Infested apples to be held for processing later should be placed in cold storage. In common storage the injury will proceed and decay may set in before the fruit can be utilized. All larvae or eggs in fruits are killed by periods of 6 weeks or more in cold storage.

THE ROSE CHAFER OR ROSE BUG

J. S. HOUSER AND C. R. CUTRIGHT

Usually about Decoration Day, swarms of rose chafers appear They are light tan in color and about ½ inch long. When disturbed, they elevate some of their long legs as if attempting to ward off the intruder. Many plants are subject to attack, but none are more severely damaged than the foliage and newly formed fruit clusters of grape. Apple, cherry, rose, peony, raspberry, peach, and a host of other plants are damaged also. Fortunately, the beetles are present for about one month only. During this time not only do the beetles feed voraciously but between times they deposit their eggs in the soil. The eggs hatch into grubs resembling undersized, ordinary white grubs, which feed on the roots of plants and develop into beetles the following year. This insect is more likely to be troublesome in areas of sandy or gravelly soil.

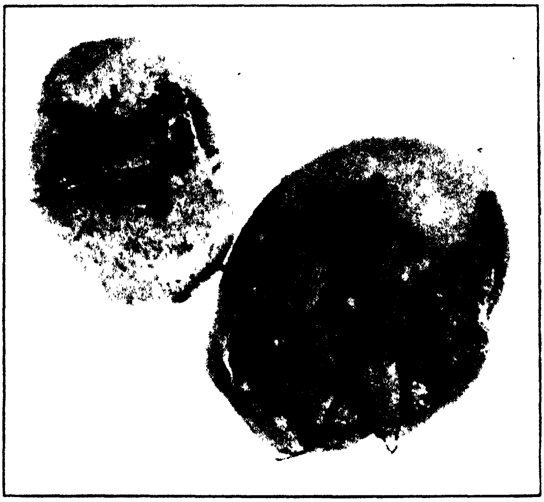

Fig. 1.—Rose chafers feeding on peach

The rose chafer is difficult to control. If one has command over an area of considerable size, such as a vineyard, many of the insects will be destroyed if the soil is cultivated several times during late May and early June. At that time the insect is in the helpless pupal stage. A little manhandling during that period is fatal.

If but a few grape vines are involved, or perhaps some choice rose plants, or even a small planting of raspberries, it is entirely practical to afford protection with a covering of inexpensive mosquito netting. The covering should be placed as soon as the first beetles appear and should not be removed until after the invasion is over. The expense is little more than that of spraying, and the degree of protection obtained is considerably more satisfactory.

Still another control procedure that is practicable, in the event a few plants only require protection, is that of hand picking and destroying the beetles each day. The best time to do this is in the early morning when the beetles are sluggish.

Rose bugs are killed if they eat foliage sprayed with poison. The formula most commonly used is 4 pounds of lead arsenate, ½ gallon of cheap syrup, and 50 gallons of water. The weakness of spraying for rose bug control is that 24 to 48 hours must elapse before the poison takes effect. During that time, the beetles do considerable damage. Also, this insect moves about freely, and, when one lot is killed, another group is likely to be on hand to continue the work of destruction. The spray application should be repeated in a week. If by the end of another 7-day period the insects are still abundant, another treatment should be applied.

It has been pointed out that there are limitations in spraying for rose-chafer control. However, it may be said with respect to vineyards, that sufficient benefit follows to make it worthwhile to use the sweetened poison formula, provided that two, and possibly three, applications are made.

When a raspberry patch is attacked, it is another story. In 1943 a series of sprays and dusts were applied to a planting near Wooster. Among the unsuccessful materials used were different forms of fluorine, several commercial brands of rotenone, and summer dinitro dusts. The only material that seemed promising was pyrethrum, which paralyzed the beetles and caused them to fall to the ground. If the fallen beetles were covered with soil or if they were sprayed with 6 per cent strength dormant oil, they were killed. Unfortunately, pyrethrum is not available this year because the entire supply is required for use by the armed forces. Due to the fact that raspberries are in bloom when the rose chafers appear, the sweetened lead arsenate formula should not be used.

Some investigators have reported that a heavy application of hydrated lime is of considerable value in repelling the beetles. The formula is 1 pound of hydrated lime mixed with 2 gallons of water. This treatment is said to be of particular value for use on peaches. It should be repeated if rains wash off the spray deposit and if the beetles persist.

VOLUNTEERS IN FOREST PLANTINGS

ROBERT R. PATON

Tree planting projects may be classified into two broad groups; namely, those whose goal is the reestablishment of permanent forest cover on the area planted, and those which have some specialized goal where the planting itself will serve the desired purpose. The first group would include, in addition to the most common general purpose forest, all erosion control plantings, esthetic plantings where the purpose is the permanent covering of unattractive sites, game shelter plantings, and others. The second group includes windbreaks, fence post and Christmas tree plantings, screens and hedges.

The problem of how to establish the permanent forest is not easily solved. Frequently, the area to be reforested is seriously eroded and the conditions are unsuitable for tree growth. Not only is the topsoil gone, but the area is exposed to severe fluctuations in both temperature and moisture, due to the absence of cover. Although the area may have supported a fine stand of oaks or maples at one time, the conditions under which those trees grew no longer exist and seedlings of these species would not survive there now. It is necessary that some intermediate step be taken before the forest of oaks or maples can be replaced.

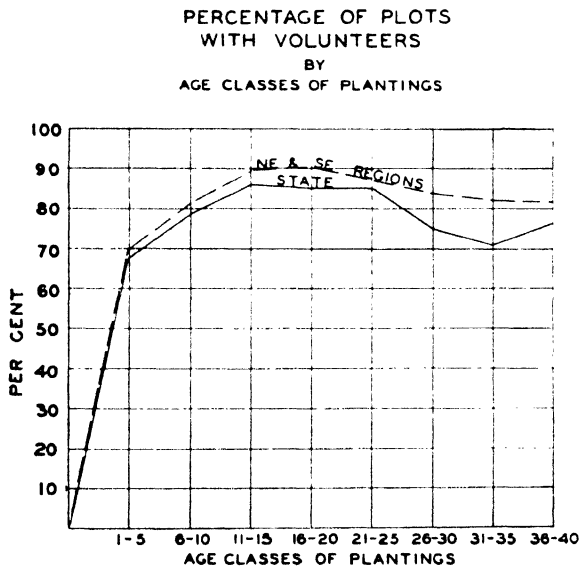

Fig. 1.—Plots with volunteers

This intermediate step may take place naturally by the seeding in of some pioneer species, such as hawthorns, sumac, hickories, soft maples, sassafras, aspens, and others, or it may be made by the artificial planting of the area with some species which can survive the conditions found there.

Many old fields in Ohio where seed is present are restocking naturally. Others have been idle for years and give every indication of remaining so for years to come, unless planted. These are the areas which should receive first attention in any planting program. The areas reseeding naturally may also need some planting, but this should be done with the viewpoint of supplementing natural seeding and only rarely, if ever, should the area be cleared before planting is done.

The species to be planted include white, red, and shortleaf pines, black locust, tuliptrees, black walnuts, white ash, red and white oaks, and others.[1]

This planting is the first step in the returning of the area to permanent forest. The next step is the infiltration of volunteer seedlings into the planting. In most instances, this will take place naturally in Ohio.

The survey of forest plantings made in Ohio showed that 76 per cent of the successful plots[2] had some volunteers present, and, in eastern Ohio where the most of the plantings occur, 90 per cent of the plantings between 10 and 20 years of age had some volunteers present. See figure 1.

TABLE 1.—Average number of volunteers per acre, by age classes of planted trees

Age	NE	SE	SW	NW	State
1- 5	338	452	382	326	398
6-10	478	698	512	269	553
11-15	686	680	633	375	665
16-20	791	884	358	30	703
21-25	956	776	1,533	25	884
26-30	1,007	547	530	505	643
31-35	650	539	435	956	548
36-40	664	514	614	100	566
Average	516	600	489	280	541

The average number of volunteers per acre was over 300 in all four regions[3] in the plantings 1 to 5 years of age. For the State as a whole, this number increased as the plantings grew older (up to the 21 to 25-year group) and then lessened. This lessening was due to the rather common practice of grazing the older plantings, most of which were catalpa. This same general trend was observed in all four regions, although the northwest region was more irregular, largely because of the small number of plantings and the high percentage of windbreaks. See table 1.

[1]Paton, Robert R., Edmund Secrest, and Harold Ezri. 1944. Ohio Forest Plantings. Ohio Agr. Exp. Sta. Bull. 647. Paton, R. R. 1944. Forest Planting in Ohio. Ohio Agr. Exp. Sta. Bimo. Bull. 29: 86-92.

[2]There were 2,507 successful plantings studied and these were divided into 8,263 plots.

[3]Ohio was divided arbitrarily into four regions in this survey, based on physiographic features and broad forest types (figure 2). The two western regions are relatively flat and have predominantly tillable, fertile land of limestone origin. Forests here are small in area, usually of about 10 to 20 acres in extent or smaller, and 50-acre woods are uncommon. The northwest region is characterized by a swamp forest type, made up of white oak, swamp white oak, elm, hickory, ash, and red maple.

The forests of the southwest region are made up of burr oak, hickory, beech, and sugar maple, with pin oak becoming common toward the south. Elm, walnut, ash, and red oak are associate species.

The two eastern regions are hilly and more heavily forested. The soils of sandstone origin are less fertile, but they are well drained. Here forests are more extensive, and in the southeast region as high as 50 to 60 per cent of a township may be wooded. The northeast region was glaciated (as were the northwest and southwest regions also) and the hills are more rolling. The forest there is predominantly beech-maple with red oak, tuliptree, and ash occurring as associated species.

The southeast region is part of the Allegheny foothills and contains a relatively small percentage of level land. The forests are predominantly of the oak-hickory type, with tuliptree, walnut, beech, maple, and, in the southern part, scrub, shortleaf, and pitch pines as associates.

Thirty-nine per cent of the plots were in the northeast region, 40 per cent in the southeast, 17 per cent in the southwest, and 4 per cent in the northwest.

The density of the volunteers per acre can be best shown by grouping them into arbitrary brackets. For the State as a whole, 24 per cent had no volunteers; 19 per cent had 1-100 volunteers per acre; 11 per cent, 101-200; 13 per cent, 201-400; and 33 per cent had over 400 per acre. The northeast, southeast, and southwest regions show a similarity in these data (table 2).

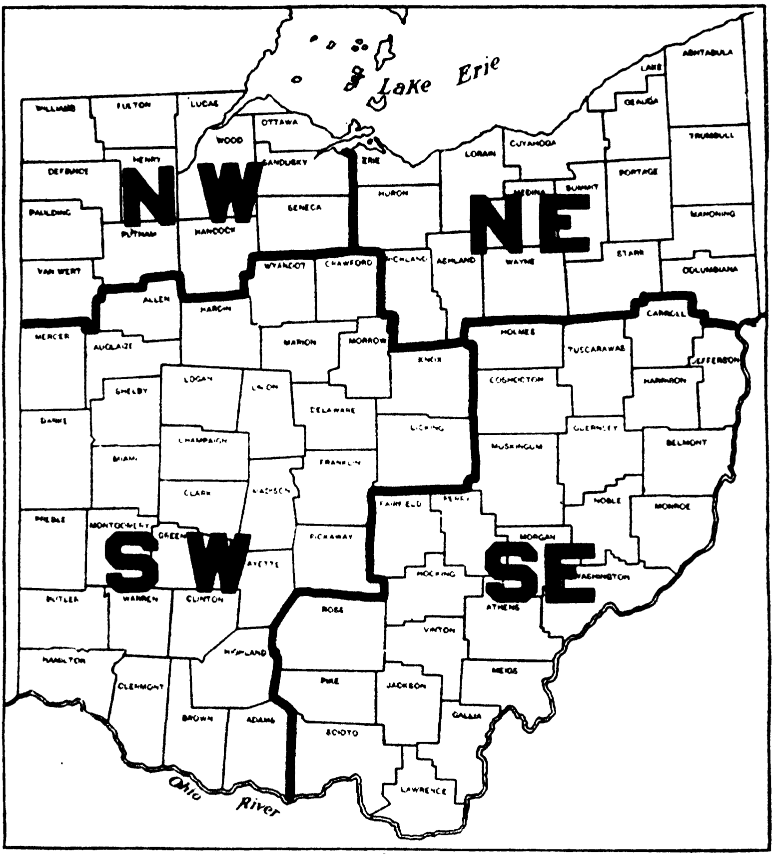

Fig. 2.—Division of Ohio by regions

It is evident that we can expect, in the majority of plantings, to find some volunteer trees present within a few years after planting, and before 20 years have passed, in a third of the plantings, there may be nearly as many volunteers as planted trees.

The species of volunteers which become established in the planting depend on the species of seed trees present and the agencies which are available to disseminate this seed. For example, light seeded species such as ash, the seed of which is disseminated by wind, will reseed an area to the east abundantly, but fields west of the tree will reseed very slowly; walnuts will be disseminated by squirrels regardless of direction; and black cherry, disseminated by birds, will be found where there are roosting or nesting places.

TABLE 2.—Density of volunteers

Density class	Per cent of plots having volunteers				
	NE	SE	SW	NW	State
Number per acre					
None	27	14	28	66	24
1- 100	20	18	23	9	19
101- 200	12	13	9	6	11
201- 400	10	15	12	5	13
401- 600	7	10	6	3	8
601- 800	6	8	5	3	6
801-1000	3	5	3	....	4
1001-1200	3	4	3	1	3
Over 1200	12	13	11	7	12
Total	100	100	100	100	100

The agencies effective in disseminating seed of forest trees in this State are wind, birds, rodents, other animals, water, and gravity, with the first three being the most important. Table 3 lists, by regions, the species found in the plantings examined and the probable agencies of dissemination of the seed. It will be noted that wind leads in the number of species disseminated, with birds second, and rodents third. The wind-borne species comprise both valuable and low quality trees; the bird-borne seed are nearly all of low quality species; and the seed disseminated by rodents are predominantly of valuable species.

TABLE 3.—Occurrence of 20 leading species[4] by regions

(Percentage based on total number of plots in each region on which volunteers occurred)

Species	NE	SE	SW	NW	State	Probable agency
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	
Black cherry	57.8	34.1	33.0	5.5	42.2	B
Elm	32.7	38.9	42.9	39.4	37.2	W
Hawthorn	32.7	19.5	16.7	3.1	23.7	BRA
White ash	24.3	32.7	26.4	11.8	23.2	W
Sugar maple	20.9	14.4	16.2	18.1	20.9	W
Oak	18.6	18.7	16.0	14.4	18.3	R
Wild apple	21.4	14.9	5.9	3.9	15.7	BRA
Sumac	11.2	22.2	7.6	....	15.3	B
Black locust	8.7	18.6	14.7	3.1	13.9	WB
Sassafras	3.3	25.2	44.1	.8	13.2	B
Hickory	7.7	18.2	10.6	7.1	12.9	R
Dogwood	8.5	17.1	4.8	3.1	11.6	B
Red maple	7.9	10.9	5.1	.8	8.6	W
Black walnut	4.5	9.4	14.3	.8	8.1	R
Tuliptree	6.8	10.4	2.1	2.7	7.5	W
Aspen	2.5	3.1	2.0	.8	2.6	W
Beech	3.5	2.1	2.4	....	2.3	R
Blackgum	.6	4.0	1.1	....	2.2	B
Sycamore	1.7	1.8	1.9	1.6	1.8	W
Honey locust	.1	1.5	4.4	....	1.4	WBA
Total number of plots on which volunteers occurred	2366	2824	1007	127	6324	....

[4]In the above table, all species of oaks are combined and considered as one, and the hickories, hawthorns, dogwoods, sumacs, and aspen are treated similarly.

TABLE 4.—Number of species[4] disseminated by each probable agency

B—Birds	9	R—Rodents	6
W—Wind	9	A—Other animals	3

[4]In the above table, all species of oaks are combined and considered as one, and the hickories, hawthorns, dogwood, sumacs, and aspen are treated similarly.

The effect of a planting on the establishment of volunteers is complex. The planting may, but to only an insignificant extent, improve the soil fertility directly. It does improve site conditions in general by providing shade (thus modifying temperatures in the summer), by checking wind velocities at ground level, by checking water run-off, and by improving soil texture through the increasing and retaining of humus. The planting may exert some detrimental influences also, such as producing a dense shade which prevents the growth of volunteers.

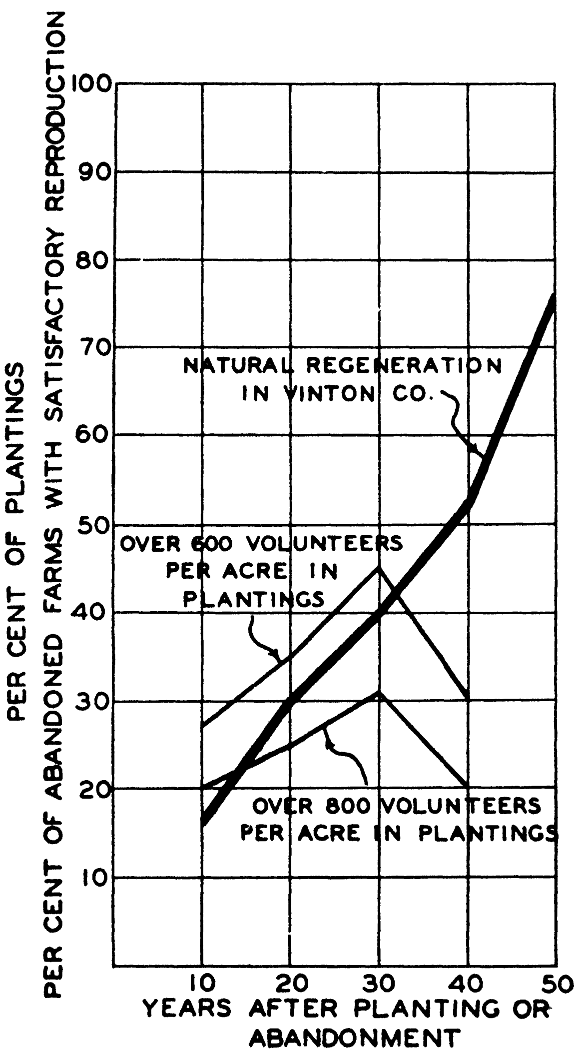

Fig. 3.—Rate of natural regeneration in old fields in Vinton County and in forest plantings in southeastern Ohio.

These factors affect the germination and growth of volunteer seedlings. The plantings also influence the amount of seed which may be deposited on the area. The checking of wind velocity tends to increase the number of wind-borne seed dropped in the area, the providing of roosts and nesting places increases the number of bird-borne seeds, and the presence of protective cover encourages the rodents to enter the field and deposit there nuts and acorns.

The areas which are devoid of tree growth due to previous cultivation or pasturing will, in many instances, return to forest eventually by natural methods. As tree growth becomes established the rate of reseeding increases, due to the influences outlined above. This rate of reseeding was shown by a study made by E. G. Wiesehuegel[5] on abandoned land in Vinton County in southeastern Ohio.

This study showed that at the end of 10 years 16.5 per cent of the areas studied were regenerating satisfactorily and by 50 years this had increased to 76.2 per cent. Some sites regenerated very slowly and he states that "heavily eroded soils were either covered with a growth of pine (native) or remained bare and continued to erode into deep gullies. This not only indicates the need of care in selecting species for reforestation, but also intimates the utter futility of attempting to regenerate hardwood trees upon such eroded lands until the lands have been restored to their former fertility."

The species Wiesehuegel reported having found on abandoned farmland were "sassafras mixed with other species such as persimmon, hickory, tuliptree (yellow poplar), and a few each of black walnut, dogwood, sugar maple, butternut, sourwood, blackgum, chestnut, cherry, aspen, and black, red, white, and scarlet oaks."

In southeastern Ohio, the survey of forest plantings[6] showed that the volunteer species found in more than 30 per cent of the plots were elm and cherry; in more than 20 per cent were sassafras, ash, and sumac; and in more than 10 per cent were hawthorn, oaks (all species combined), black locust, hickories, dogwood, sugar maple, wild apple, red maple, and tuliptree (table 3).

The rate at which volunteers entered the plantings in southeastern Ohio is shown in table 5. A comparison of this rate with that of the rate of regeneration found by Wiesehuegel is presented graphically in figure 3. Wieseheugel does not state what number of trees per acre he set as being satisfactory. If 600 or more volunteers per acre are considered satisfactory, then the volunteers are apparently coming into the plantings in southeastern Ohio more rapidly than they did in open fields in Vinton County. If 800 or more are considered necessary to be satisfactory, the volunteers come in to the plantings more rapidly at first and then appear to lag behind the open field regeneration.

The curves of number of volunteers in forest plantings show a decline beginning at 30 years. This may be significant, but many of the older catalpa plantings were pastured and the volunteers were fewer in number for this reason. Other factors may be involved also, requiring further study.

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[5]Wiesehuegel, E. G. 1922. Forest Regeneration on Abandoned Farm Lands in Ohio. Ohio Agr. Exp. Sta. Bull. 516. 119-120.

[6]Paton, Robert R., Edmund Secrest, and Harold Ezri. 1944. Ohio Forest Plantings. Ohio Agr. Exp. Sta. Bull. 647.

Fig. 4.—An all-aged forest in southern Ohio, typical of the original stand that once covered the State

TABLE 5.—Occurrence of volunteers by age of planting in southeastern Ohio

Density of volunteers	Age of planting, in years				Total No. of plots
	1-10	11-20	21-30	31-40	
No. per acre	*No. of plots*	*No. of plots*	*No. of plots*	*No. of plots*	
None	374	34	20	23	451
1- 100	458	97	15	21	591
101- 200	308	92	8	9	417
201- 400	321	148	17	19	505
401- 600	212	101	16	11	340
601- 800	157	74	19	11	261
801-1000	118	43	12	6	179
1001-1200	74	27	11	5	117
Over 1200	272	109	20	13	414
Totals	2294	725	138	118	3275

Whether the study made by Wieseheugel is typical of all southeastern Ohio and whether the comparison between the planting survey data and his data is significant cannot be determined. This arbitrary comparison gives some indication of the probable results of natural regeneration in open fields and plantings in southeastern Ohio.

The goal of a reforestation program is to reestablish productive forests such as shown in figure 4 over much of the land now idle in Ohio. Plantings are necessary on certain areas due to the absence of seed trees, to active erosion conditions, or other site conditions which are unfavorable to the germination and survival of young volunteer seedlings. On other areas, some planting may be essential to improve the character of the native stand, and frequently no planting at all is needed. It is important that the possibilities of native regeneration taking place be fully considered before planning a reforestation project.

GOOD PASTURAGE SAVES FEED AND EXPENSE FOR POULTRY RAISERS

D. C. KENNARD AND V. D. CHAMBERLIN

This year more than ever before good pasturage will be the key to successful and economical poultry raising. In fact, it is the best answer to the question foremost in the minds of many poultrymen as to whether, in view of recent egg and poultry market uncertainties and the scarcity and high price of feed, they should continue raising poultry as usual, curtail operations, or quit altogether.

Whether or not the poultry raiser should continue as usual, curtail operations, or quit altogether often depends upon whether he is a farm poultry raiser, a commercial egg producer, a backyarder, or a commercial broiler producer. Assuming (and certainly it seems to be a safe assumption) that eggs and poultry will be in good demand at reasonably satisfactory prices during the balance of the year, it would seem that farm poultry raisers, who produce the bulk of the eggs, with plenty of good pasturage available would be well advised to brood and raise their usual number of pullets this year, despite the scarcity and high price of feed. The farm poultry raiser with plenty of range and pasturage for his chicks and growing pullets is in the best position to carry on as usual, because he is less dependent upon purchased feeds than other types of poultry raisers. Consequently, he should take full advantage of his favorable position under the present wartime situation.

The larger-scale commercial egg producer, who is in a position to raise his pullets on good pasturage, is also in a favorable position to cope with wartime feed problems. However, in case unforeseen emergencies arise, large-scale operations are necessarily attended with greater liabilities than smaller-scale operations of farm poultry raisers.

Backyard poultry raisers, who feel pleased and encouraged from last year's undertakings, may well continue on the basis of their past year's results and experiences. Many of last year's beginners will, no doubt, be missing from the ranks this year. The inducements to new recruits of backyarders are less urgent this year than last.

In the case of the commercial broiler producers it is a different matter, for the government and the poultry industry have requested a substantial reduction in commercial broiler production. For various reasons, including the scarcity of feed, this phase of poultry raising seems to be in the least favorable position of all. Here, again, the farm poultry raiser who can raise 3-pound broilers or 4- to 5-pound roasters on range with good pasturage is in the best position to do so. Many will, no doubt, find this a desirable and profitable supplement to their usual undertakings in poultry raising.

Raising chickens in colony houses or range shelters on good pasturage is the best way around the scarcity and high price of purchased feeds. Besides the economy of raising pullets on a good, clean range where good pasturage is available, a better quality, ready-to-lay pullet can generally be produced on pasturage. Thus, good pasturage at the rate of 300 pullets per acre will

often yield $75 to $150 an acre. Farmers may well keep these figures in mind when they face the question of whether the alfalfa or clover should be let go to hay or used as pasturage for pullets or roasters.

Chickens on good pasturage need only a simple, comparatively inexpensive mash and whole grain. This is now a well-established fact. Many Ohio raisers, as well as the poultry division of the Ohio Agricultural Experiment Station, have followed this procedure[1] for the growth of ready-to-lay pullets, broilers, and roasters during the past 4 years and have saved much feed and expense by so doing.

In view of the successful results in the growth of pullets on pasturage supplemented with whole grain and a simple range mash, the question arose, "What would happen if pullets on good pasturage were fed only whole grain without any mash?" This might have seemed a foolish question in peacetime. Nevertheless, an experiment was conducted last year by the Ohio Agricultural Experiment Station with 500 White Leghorn pullets; 200 of these had access to an ordinary grass and weed range and a nearby cornfield, both of which were comparable to range conditions on many Ohio farms. All of the pullets received the regular range starter mash during the first 7 weeks, after which 200 of the pullets were moved to two-colony houses on another range where they were fed whole grain without mash until they were ready to lay. The remaining group of 300 pullets was continued on good pasturage and fed whole grain and the regular range growing mash. Surprising as it may seem, the pullets on whole grain and pasturage without mash did as well and were equal in quality to those given the regular range ration with mash. The pullets on pasturage and whole grain without mash were 2 weeks later in starting to lay and a little lighter in weight when taken to the laying house. Upon receiving a well-balanced, laying ration, however, they soon caught up with their mash-fed sisters in egg production and body weight. After 4 months in the laying house, they have equaled the range mash-fed pullets in egg production and body weight.

While the whole grain and pasturage proved successful in the experiment just described, it obviously has its limitations. It is of particular interest to the farmer who grows 100 to 300 or 400 pullets with plenty of grass, clover, weeds, and insects available. Moreover, there was plenty of rainfall during the summer of 1943. During a long period of hot, dry weather, the range may fail to meet the requirements, in which case the pullets would need to receive additional protein as provided by the range mash. Despite the limitations of the whole grain-pasturage procedure, farm poultry raisers may well keep in mind that they can, if necessary, grow first-class pullets on good pasturage and whole grain without mash after the first 7 weeks, especially during wartime feed-scarcity conditions.

The value of good pasturage and what can be accomplished with growing pullets or roasters on good pasturage has been described. Now just what is meant by good pasturage? Good pasturage for chickens involves a number of factors, such as succulent green feed, isolation from older chickens, and ample space.

While clover and alfalfa are desirable for poultry pasturage, a range that will provide plenty of edible succulent grasses and weeds will serve the purpose. The Station's pullets raised on whole grain and pasturage had access

[1]Published information on this subject can be obtained by writing the Ohio Agricultural Experiment Station at Wooster, Ohio.

to orchard grass, bluegrass, weeds, hedge rows, and a cornfield, such as are commonly found on most Ohio farms. It is often necessary to mow the grass and weeds during the late spring and summer to encourage continued growth and succulence of the grass, weeds, or clover, especially when there is a considerable number of chickens being pastured. A good range will also provide insects which make a valuable supplement to the green feed.

When the chicks are confined to a limited range, it is necessary to avoid over-stocking. An acre of range will generally accommodate 200 to 300 pullets, depending upon the kind of vegetation, the soil, and the weather. A given acre of pasturage will accommodate a somewhat smaller number of chickens receiving whole grain and no mash than if they received a protein mash supplement.

The range for chicks and growing pullets should be well isolated from older disease- and parasite-carrying birds. Attempting to raise chicks and growing pullets on a range frequented or recently contaminated by older chickens is the most frequent cause for the failure of the farm poultry raiser to grow first-class pullets which will live and lay as they should. In order to avoid the transmission of diseases and parasites from older birds to chicks and growing pullets, it is often necessary to confine the layers indoors or to sun yards so that the outdoor range may be kept safe for the chicks and growing pullets.

From the foregoing considerations it seems that farm poultry raisers having plenty of good pasturage will be well advised if they grow their usual number of pullets this spring for egg production next fall and winter, when, according to present prospects, there will be a scarcity of eggs which will bring satisfactory prices.

More than ever, the farm poultry raiser should think in terms of growing the chickens on pasturage to keep feed requirements at a minimum. More than ever, should he guard against the failure of the pullets as layers because of their previous exposure to the diseases and parasites of older birds or from a disease-contaminated range. A well-isolated, clean range with plenty of pasturage is the keystone to successful and economical poultry raising.

FEED, DON'T WASTE, BY-PRODUCT INCUBATOR EGGS

D. C. KENNARD AND V. D. CHAMBERLIN

Of the hundred million or so eggs that go into incubators in Ohio to hatch 50 to 60 million chicks each year, a third to a half of them, or about 6 million pounds of infertile dead embryo and dead-in-shell eggs, become a by-product available for feeding purposes.

Everybody agrees that cooked incubator eggs are valuable for feeding poultry, but just how valuable are they? One answer to this question was secured from a broiler-feeding experiment just completed at the Ohio Agricultural Experiment Station. In this experiment, 5.5 cents for each pound of cooked incubator eggs were realized from increased gains in weight of broilers and from decreased feed requirements.

The experiment was conducted with two groups, each consisting of eighty 2-week old White Leghorn mixed pullets and cockerels in batteries. The control group received the 18 per cent protein ration composed of yellow corn, coarsely ground, 40; wheat middlings, 20; wheat bran, 10; meat scraps, 50 per cent protein, 2; soybean oil meal, 15; dried skimmilk, 5; alfalfa meal (17 per cent protein), dehydrated, 5; salt, 1; bone meal, 1; oyster shell, chick-size, 2; vitamin-D feeding oil (400 D), 0.1. The other group received the control ration without oyster shell, supplemented with cooked incubator eggs. A still greater saving could have been realized from the use of the incubator eggs if the dried milk had been omitted from the egg ration. The dried milk was included in this experiment for comparison with other rations included in the experiment.

TABLE 1.—Weights of White Leghorn broilers, feed consumption, and returns over cost of mash

January 3 to March 14, 1944—10 weeks*

Ration	Weight and number of birds at end of test				Total gain in 10 weeks		Feed consumption in 10 weeks				Returns over cost of mash
	Cockerels		Pullets				Mash		Cooked incubator eggs	Pounds mash per pound of feed	
	Number	Weight per bird	Number	Weight per bird	Pounds†	Value‡	Pounds	Cost§			
		Lb.		*Lb.*					*Lb.*		
Control....	37	2.08	33	1.80	142.1	$39.79	581	$20.33	None	4.09	$19.46
Control + cooked incubator eggs......	33	2.47	45	2.00	156.1	$43.71	449.5	$15.73	155	2.82	$27.98

*Chicks 2 weeks old when experiment started.
†Weight of chicks at beginning of experiment, 14.4 pounds, deducted.
‡Calculated at 28 cents per pound.
§Calculated at $3.50 per cwt.

Both the cockerels and pullets receiving the cooked incubator eggs made substantially greater gains. The smaller percentage of cockerels (42 versus 53 per cent) in this group made the total gain correspondingly less than it would have been had there been the same number of cockerels and pullets in each group.

The feeding of 155 pounds of cooked incubator eggs in this experiment yielded 14 pounds (9.8 per cent) more live weight of chickens ($14 \times \$.28 = \$3.92$) and made possible a saving of 131.5 pounds of mash ($131.5 \times \$.035 = \$4.60$); thus, a total saving of $8.52 may be credited to the feeding of incubator eggs. Had the dried milk been omitted, still greater returns could have been realized from the eggs. Despite the use of 5 per cent dried skimmilk, 5.5 cents a pound, or 6 to 7 cents a dozen, were realized from the incubator eggs, the bulk of which becomes a total loss to the poultry industry even during the critical wartime scarcity of less valuable feedstuffs. Why is this true? Because the supply of incubator eggs is seasonable and because more or less time, labor, and inconvenience attend their use for feeding purposes. Nevertheless, this most valuable of all feedstuffs for poultry should be used as feed to the fullest extent possible to aid in relieving the wartime scarcity of other critical animal feed products.

METHOD OF FEEDING

The infertile dead embryos and dead-in-shell eggs are boiled 30 to 45 minutes (after water actually boils) and then passed through a food chopper or a sausage mill. The ground egg material may be fed either on top of the dry mash or mixed with some of the dry mash and fed as a moist mash. In either case, the amount fed should not exceed that which the birds will clean up within 20 to 30 minutes once or twice daily. In the experiment with broilers, a mixture of 1 part of mash to 3 parts of cooked egg material by weight was fed at 8 a. m. and 2 p. m. daily.

Precautions need to be exercised in the feeding of a high-powered product like incubator eggs. First, the eggs must be boiled 30 to 45 minutes to avoid the transmission of diseases and to prevent digestive disorders. Second, they must be fed soon after cooking. The eggs may be stored in a cool, dry place (40° to 60° F.) for 1 to 2 weeks before cooking and, if they are not ground, they may be kept a week after boiling before feeding, provided they are kept under favorable storage conditions. Cooked incubator eggs soon become unfit for feeding when the temperature rises above 60° F. The egg material spoils quickly after grinding and should be fed the day it is ground.

PALATABILITY AND FEEDING VALUE OF DIFFERENT CORNS FOR PIGS

W. L. ROBISON

INTRODUCTION

Hybrid and open-pollinated corns for pigs were compared in tests made at the Ohio Agricultural Experiment Station; the results were published in the November-December, 1939, Bimonthly Bulletin (1). The tests were prompted by the claims of some feeders that when pigs had access to both kinds of corn, they preferred the open-pollinated to the hybrid corn and by the claims of others that when pigs were switched from open-pollinated to hybrid corn there was a marked reduction in feed consumption. Some believed the hardness of hybrid corns caused them to be less palatable and to have a lower feeding value than open-pollinated corns.

In a palatability test, pigs showed strong preferences for some corns over others. The preferences were not for open-pollinated as against hybrid varieties, but they were closely aligned with lowness in moisture. The moisture contents ranged from 16.2 to 20.8 per cent. The test was started in January and concluded in June. The pigs were fed indoors, where the temperature was always above freezing.

Vestal (2, 3) found that, when groups of pigs had access to three varieties of shelled corn, thev preferred certain varieties to others but that, when each variety was fed to a separate group of pigs, the group receiving the least palatable variety made as efficient and practically as rapid gains as the group receiving the most palatable of the three corns.

Subsequent to the earlier Ohio tests, a study of some of the factors which it was thought might possibly influence the palatability and feeding value of corn was undertaken. Among the factors considered were (a) hybrid as against open-pollinated corns, (b) immaturity, (c) the freezing of immature corn, (d) hardness, (e) moisture content, and (f) moldiness. Circumstances did not permit growing the corn under as exacting conditions or making as thorough a study of all of the questions involved as was desired. The information obtained is presented but it does not constitute a report of unequivocal finality.

An interesting phase of the question that was not dealt with is the influence of soil productivity, type, and soil reaction on the nutritive properties of the corn produced. Presumably, such factors would have less influence on the character of the grain or seed than upon the character of the plant. Sayre (4) has reported that applications of deficient elements first increase growth of the plant and production of grain, and then, if applied in greater amounts than are necessary for maximum yields, accumulate for the most part in the leaves and stems and only slightly in the grain.

1. Robison, W. L. 1939. Hybrid and Open-pollinated Corns for Pigs. Ohio Agr. Exp. Sta. Bimo. Bull. 24: 156-163.
2. Vestal, C. M. 1939. Open-pollinated and Hybrid Corn for Growing Fattening Hogs on Pasture. Mimeo. Lft. An. Hus. Dept., Ind. Agr. Exp. Sta.
3. Vestal, C. M. 1940. Open-pollinated and Hybrid Corns for Fattening Hogs on Pasture. Mimeo. Lft. An. Hus. Dept., Ind. Exp. Sta.
4. Sayre, J. D. 1944. Composition of Corn Plants with Heavy Fertilization. Ohio Agr. Exp. Sta. Weekly Press Bull., No. XXVIII-49.

In each of the three experiments a supplemental mixture of tankage, 19; soybean oil meal, 39; cottonseed meal, 9; ground alfalfa, 25; minerals, 8 was used. Toasted, extracted soybean oil meal sold to contain 44 per cent of protein and expeller cottonseed meal sold to contain 41 per cent of protein were fed. The mixture averaged approximately 36 per cent of protein. It was kept before the pigs in one compartment and shelled corn in the other compartments of a self feeder. The average amounts of supplement taken daily per head and the average percentages in the total feed are given in the tables.

During the forepart of the tests, or while the pigs were young, they took relatively high percentages of supplement. As the pigs became older, they usually took as much, or more, daily a head but less in relation to the amount of corn consumed. The effect of age on the consumption of supplement is shown in tables 7 to 10, inclusive, which summarize the results for the fore and latter parts of the tests, as well as for the entire time.

EXPERIMENT 1

In the tests, Ohio hybrid K35 was used as the standard corn with which the others were compared. In 1940 some K35 was planted at the usual time and some was planted late, June 21, so that it would be immature at the close of the growing season. A portion of the late corn was harvested at the time of the first killing frost and then dried so that it would keep without molding. At the time of harvesting it contained 56.5 per cent of moisture. The other portion was left in the field a month longer and allowed to undergo freezing. It was then harvested and dried so that it could be stored until it was fed.

To secure further information on the effect of maturity, U. S. 13, a hybrid corn adapted to a longer growing season than prevails in Wayne County, was grown for comparing with the earlier-maturing K35, a variety that is adapted to the locality. Included in the corns grown for the test were U. S. 65, which is a hard hybrid, and yellow flint, which is still harder.

Due to unforeseen circumstances which were beyond the control of the investigator, not enough flint corn was grown for the test. Additional flint corn was eventually located but not until after the supply grown was exhausted, so that it was necessary, as was explained in the footnote to table 1, to feed the group commercial dent corn for a period of 14 days.

The supply of early harvested, dried, immature corn was exhausted after 12 weeks, when the group receiving it averaged 164 pounds in weight. From then on they were fed regular commercial corn.

The results of the test for the first 12 weeks—that is, until the supply of early harvested immature corn was exhausted—are presented in table 2. After it was dried, the immature corn was rather shriveled and chaffy. It was higher in protein, fiber, and ash but lower in nitrogen-free extract and fat than mature corn of the same variety. Both were grown on productive soil but not in the same field.

TABLE 1.—Factors possibly affecting the feeding value of corn; Experiment 1

Started December 10, 1940 Shelled corn and supplement, self-fed separately	1 K35, Mature	2 K35, Immature dried	3 K35, Immature frosted dried	4 U.S.13, Long season	5 U.S.65, Hard	6 Yellow flint, Very hard
Supplement	Tankage, 19; soybean oil meal, 39; cottonseed meal, 9; ground alfalfa, 25; minerals, 8					
Moisture content, Oct. 17, per cent	28.1	56.5	56.5	30.3	25.5	32.8
Average moisture in corn as fed, per cent	**20.82**	**15.73**	**11.35**	**24.32**	**17.95**	**21.05**
Composition, per cent:*						
Protein	7.08	10.11	8 75	8.23	7.73	8.22
Fat	0.78	0.02	0.03	1.10	0.69	0.55
Fiber	2.26	3.79	2.89	7.96	4.70	5.54
Ash	1.36	1.45	1.50	2.97	1.27	2.17
Kernels high in horny starch, per cent	63	77	90	74	88	73
Average crushing pressure, pounds	66	....	....	....	86	....
Supplement in total feed, per cent	12.3	9.4	11.5	12.2	11.2	13.3
Pigs at start	14	14	14	14	14	14
Initial weight per pig, pounds	64.0	64.6	64.8	63.9	65.1	64.5
Pigs at close	12	14	14	13	13	14
Final weight per pig, pounds	214.9	209.9	215.2	206.6	216.8	211.0
Average daily gain, pounds	**1.20**	**1.30**	**1.34**	**1.35**	**1.43**	**1.31**
Days to gain 160 pounds	134	124	120	119	112	123
Daily feed per pig, pounds:						
Shelled corn, 15.5 per cent moisture	4.35	4.72	4.77	4.71	4.88	4.70
Supplement	0.61	0.49	0.62	0.66	0.61	0.72
Total	4.96	5.21	5.39	5.37	5.49	5.42
Feed per 100 pounds gain, pounds:						
Shelled corn, 15.5 per cent moisture	363.12	364.06	355.09	350.16	340.90	359.45
Supplement	50.79	37.75	46.25	48.62	42.93	54.95
Total	**413.91**	**401.81**	**401.34**	**398.78**	**383.83**	**414.40**
Cost of feed per 100 pounds gain	$ 9.00	$ 8.57	$ 8.67	$ 8.66	$ 8.28	$ 9.07

Toasted, extracted soybean oil meal sold to contain 44 per cent of protein and 41 per cent protein expeller cottonseed meal were used.

Minerals=Salt, 19.2; limestone, 38.4; special steamed bone meal, 38.4; ferrous sulfate, 4.

Two pigs, weighing 196.5 pounds, were taken out of Lot 1 February 18; a 63.5-pound pig was taken out of Lot 4 on December 24; and a 103-pound one out of Lot 5 January 20.

Pigs remaining in Lot 1 at the close of the test gained 1.26 pounds daily a head, or at the rate of 160 pounds in 127 days.

Lot 2 was fed immature dried corn for 84 days, when the supply was exhausted, and then regular purchased corn was fed for the last 35 days. Up to the 84th day, Lots 1, 2, 3, 4, and 5 gained 1.11, 1.18, 1.18, 1.25, and 1.32 pounds daily a head and required 405.70, 386.07, 399.01, 385.18, and 376.41 pounds of feed per 100 pounds of gain, respectively.

Lot 6 was fed regular purchased dent corn from the 35th to 49th day and flint corn for the remainder of the test.

*To make them comparable, the figures for the protein, fat, fiber, and ash in the corns are on the basis of a moisture content of 15.5 per cent.

PRICES USED: Shelled corn, 2.0 cents; oats, 2.375 cents; tankage, 4.0 cents; commercial liver meal, 8.0 cents; soybean oil meal, 44 per cent protein, 3.25 cents; cottonseed meal, 3.2 cents; ground alfalfa, 2.0 cents; cod-liver oil, 25.0 cents; salt, 1.25 cents; ground limestone, 0.75 cent; special steamed bone meal, 3.0 cents; ferrous sulfate, 5.0 cents; grinding corn, 0.1 cent and grinding oats, 0.15 cent a pound.

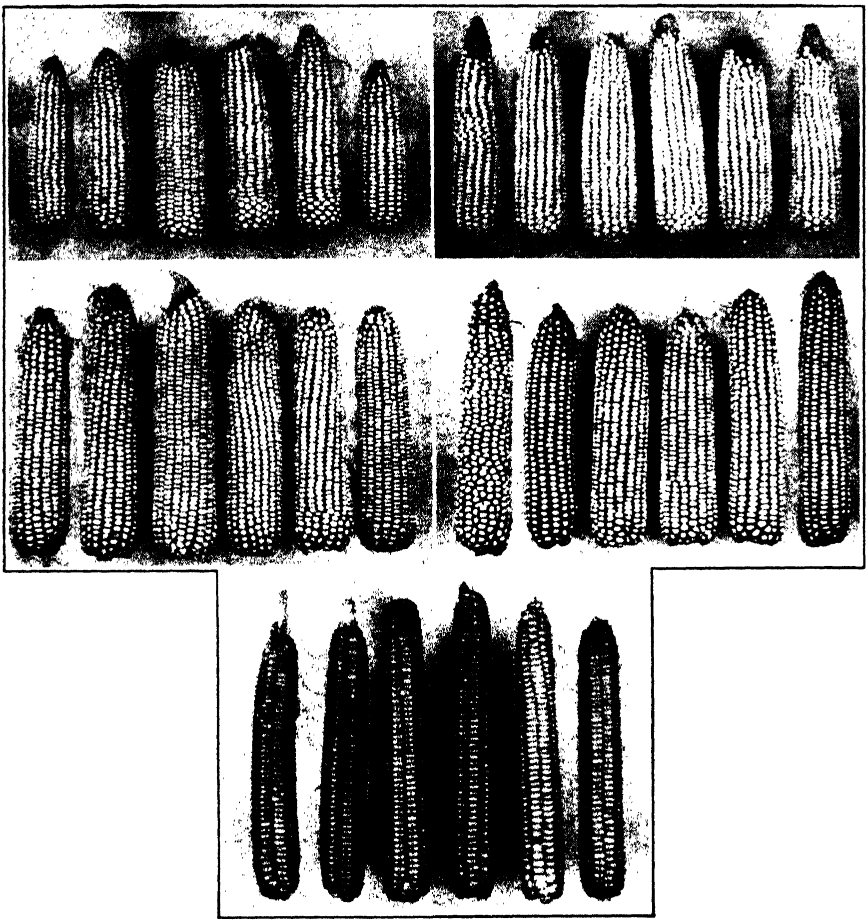

Fig. 1.—Experiment 1: Top—*left*, K 35, mature; *right*, K 35, immature. Middle—*left*, U. S. 13; *right*, U. S. 65. Bottom—yellow flint

Pigs fed the immature corn took less supplement daily a head than those fed the mature corn. Apparently freezing did not materially impair the palatability or feeding value of the immature corn. It was dried as it was harvested, so that it could be kept without molding.

No very satisfactory plan for determining the hardness of corn was worked out. The one used was to dry the corn thoroughly, then determine on an Olsen dynamometer the pressure required to crush the kernels when they were placed on edge in the machine. Since the kernels of dent corn are relatively long and more or less rectangular in shape and since they contain a comparatively small germ, whereas flint kernels are short and more nearly round and contain a relatively large germ that extends practically across the kernel, flint kernels crush much easier in the machine than do dent kernels.

TABLE 2.—Data for Experiment 1 while Lot 2 was fed immature dried corn

Started December 10. 1940 Shelled corn and supplement, self-fed separately	1 K35, Mature	2 K35, Immature dried	3 K35, Immature frosted dried	4 U.S.13, Long season	5 U.S.65, Hard	6 Yellow flint, Very hard
Supplement	Tankage, 19; soybean oil meal, 39; cottonseed meal, 9; ground alfalfa, 25; minerals, 8					
Average moisture in corn as fed, per cent	**20.8**	**15.7**	**11.3**	**24.3**	**17.9**	**21.0**
Supplement in total feed, per cent	14.5	10.7	13.6	13.9	12.8	15.2
Pigs at start	14	14	14	14	14	14
Initial weight per pig, pounds	64.0	64.6	64.8	63.9	65.1	64.5
Pigs at close	12	14	14	13	13	14
Final weight per pig, pounds	157.5	164.0	163.5	170.2	177.4	163.0
Average daily gain, pounds	**1.04**	**1.18**	**1.18**	**1.25**	**1.32**	**1.17**
Days to gain 160 pounds	155	136	136	129	121	137
Daily feed per pig, pounds:						
Shelled corn, 15.5 per cent moisture	3.60	4.08	4.05	4.14	4.34	4.04
Supplement	0.61	0.49	0.64	0.67	0.64	0.72
Total	4.21	4.57	4.69	4.81	4.98	4.76
Feed per 100 pounds gain, pounds:						
Shelled corn, 15.5 per cent moisture	347.06	344.73	344.63	331.72	328.28	344 68
Supplement	58.64	41.34	54.38	53.46	48.13	61.55
Total	**405.70**	**386.07**	**399.01**	**385.18**	**376.41**	**406.23**
Cost of feed per 100 pounds gain	$ 8.94	$ 8.31	$ 8.75	$ 8.46	$ 8.21	$ 9.00

The 12 pigs remaining in Lot 1 at the close of this period gained 1.11 pounds daily a head, or at the rate of 160 pounds in 145 days.
For prices see footnote to table 1.

Some have estimated the relative hardness of corns by the water absorbed in a given length of time. Others have thought that the power required in grinding might be indicative of hardness. Since a hard substance may shatter more easily than a soft one, this would not necessarily reflect the relative hardness. The depth of penetration of a needle under a given amount of pressure would probably be a reasonably reliable measure of hardness.

EXPERIMENT 2

In 1941, Woodburn, immature and mature K35, U. S. 13, U. S. 65, and yellow flint corns were grown for the experiment. The Woodburn and flint corns were grown on fertilized, upland sod ground which had previously been somewhat impoverished. The U. S. 65 was grown on fertilized and manured, bottom sod ground which was in a high state of productivity. The U. S. 13 and standard K35 were grown on manured hog forage plots which were highly productive. The early harvested K35 was grown on rotated, fertilized, and manured upland sod ground.

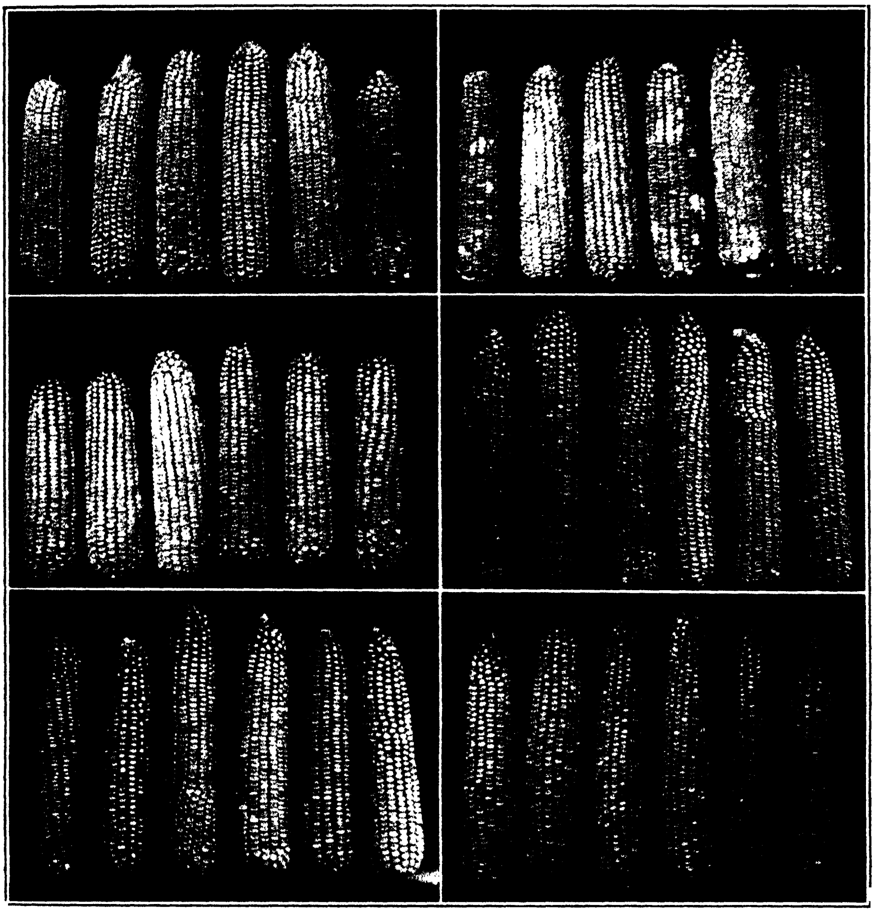

Fig. 2.—Experiment 2: Top—*left*, Woodburn; *right*, K 35, immature, dried. Middle—*left*, K 35, mature; *right*, U. S. 13. Bottom—*left*, U. S. 65; *right*, U. S. 65, dried.

The immature K35 was planted at the normal time but was harvested from August 29 to September 3, when it contained 53 per cent of moisture. It was dried so as to keep without molding and when fed contained an average of 13.9 per cent of moisture.

During the winter, new corn is not yet as dry and hard as it becomes during the summer. One group of pigs in the second test was fed U. S. 65 corn which had been put through the drier so that it would be as dry and hard as if it were fed in the summer. The undried U. S. 65 contained an average of 16.1 per cent of moisture when fed, and the dried, an average of 9.5 per cent.

After the corns had been dried, and with the grains placed on edge, average pressures of 103 and 82 pounds were required to crush grains of the U. S. 65 and of the mature K35 corns, respectively. Table 3 gives the analyses of the different corns fed in the 1941 experiment and shows the performance of the pigs to which they were fed.

TABLE 3.—Factors possibly affecting the feeding value of corn; Experiment 2

	1	2	3	4	5	6	7
	Woodburn Open-pollinated	K35 Mature	K35 Immature dried	U.S.13 Long season	U.S.65 Hard	U.S.65 Hard dried	Yellow flint, Very hard
Supplement	Tankage, 19; soybean oil meal, 39; cottonseed meal, 9; ground alfalfa, 25; minerals, 8						
Moisture content October 20	20.9	29.9	....	29.2	22.8	22.8	24.4
Average moisture in corn as fed, per cent	**18.00**	**17.25**	**13.92**	**18.97**	**16.07**	**9.52**	**17.77**
Composition, per cent:*							
Protein	7.60	9.24	8.66	9.81	9.11	8.79	9.47
Fat	2.18	2.19	2.10	1.59	1.14	1.26	1.45
Fiber	1.64	1.67	1.94	1.67	1.59	1.55	1.28
Ash	0.95	1.20	1.50	1.33	1.29	1.18	1.14
Kernels high in horny starch, per cent	63	23	....	74	88	....	....
Average crushing pressure, pounds	....	82	....	....	103	....	....
Supplement in total feed, per cent	12.9	11.7	12.5	12.6	12.5	13.9	12.7
Pigs at start	13	14	14	14	14	14	15
Initial weight per pig, pounds	61.7	61.2	62.2	61.7	61.7	61.2	61.4
Pigs at close	13	14	14	14	13	13	15
Final weight per pig, pounds	206.2	206.8	200.7	201.9	204.7	199 8	194.2
Average daily gain, pounds	**1.29**	**1.30**	**1.32**	**1.32**	**1.24**	**1.21**	**1.27**
Days to gain 160 pounds	125	124	122	122	130	133	127
Daily feed per pig, pounds:							
Shelled corn, 15.5 per cent moisture	4.50	4.56	4.49	4.52	4.11	4.46	4.61
Supplement	0.67	0.60	0.64	0.65	0.59	0.72	0.66
Total	5.17	5.16	5.13	5.17	4.70	5.18	5.27
Feed per 100 pounds gain, pounds:							
Shelled corn, 15.5 per cent moisture	349.41	350.81	339.86	343.35	331.65	369.58	364.09
Supplement	51.87	46.38	48.81	49.46	47.31	59.72	52.03
Total	**401.28**	**397.19**	**388.67**	**392.81**	**378.96**	**429.30**	**416.12**
Cost of feed per 100 pounds gain	$ 8.76	$ 8.60	$ 8.46	$ 8.99	$ 8.25	$ 9.43	$ 8.96

*On a basis of 15.5 per cent of moisture.

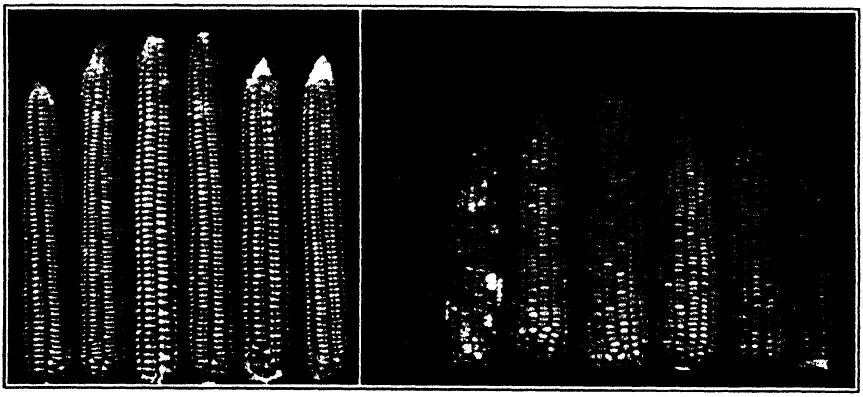

Fig. 3.—Left, Experiment 2, Yellow flint. Right, Experiment 2, Woodburn; K 35, immature, dried; K 35, mature; U. S. 13; U. S. 65; U. S. 65, dried; Yellow flint.

TABLE 4.—Hybrid and open-pollinated corns for pigs

	Open-pollinated corn	Hybrid corn
Number of comparisons	8	8
Pigs at start	112	113
Initial weight per pig, pounds	57.0	56.9
Pigs at close	108	109
Final weight per pig, pounds	204.1	204.1
Average daily gain, pounds	**1.43**	**1.41**
Days to gain 160 pounds	112	114
Daily feed per pig, pounds:		
Corn, 15.5 per cent moisture	4.52	4.56
Supplement	1.05	1.03
Total	5.57	5.59
Feed per 100 pounds gain, pounds:		
Corn, 15.5 per cent moisture	315.77	323.85
Supplement	73.36	72.88
Total	**389.13**	**396.73**
Cost of feed per 100 pounds gain	$ 8.85	$ 8.90

As explained in the text, other materials than those in the supplement previously given were used in some of the comparisons. The kinds of feed and the average amounts of each were as follows:

	Open-pollinated corn groups		Hybrid corn groups	
	Daily feed per pig	Feed per 100 lb. gain	Daily feed per pig	Feed per 100 lb. gain
	Lb.	*Lb.*	*Lb.*	*Lb.*
Oats	.04	2.77	.04	2.75
Liver meal	.03	2.22	.03	2.07
Tankage	.31	21.84	.31	21.86
Soybean oil meal	.36	25.29	.35	25.10
Cottonseed meal	.01	.55	.01	.53
Ground alfalfa	.22	15.00	.21	14.92
Minerals	.08	5.64	.08	5.61
Cod liver oil	.0007	.05	.0006	.04
Total	1.05	73.36	1.03	72.88

Of the open-pollinated corn, 32.4 per cent, and of the hybrid corn, 33.2 per cent, was shelled and the remainder ground.

For prices see footnote to table 1.

The analyses indicated that the immature K35, differing from that in the previous test, was lower in protein than the mature K35. Since they were grown in different places, this is not necessarily an exception to the findings that the solids of immature corn are higher in protein than the solids of mature corn.

COMPARISONS OF OPEN-POLLINATED AND HYBRID CORNS

Table 4 summarizes eight comparisons of open-pollinated and hybrid corns for pigs. All were made during the winter. Ground corn was fed in five and shelled corn in three of the comparisons. When ground corn was fed, the corn and supplement were mixed so that both groups were compelled to take the same percentages of supplement in the total feed. When shelled corn was fed, it and the supplement were self-fed separately.

In one comparison, some ground oats were mixed with the supplement. In another, some of the pigs became somewhat stiff or crampy and were given cod-liver oil, at the rate of 0.4 per cent of the total feed, to overcome the condition. In six of the eight comparisons, some commercial liver meal was substituted for a part of the tankage until the pigs averaged approximately 120 pounds in weight. In one, cottonseed meal was substituted for a part of the soybean oil meal.

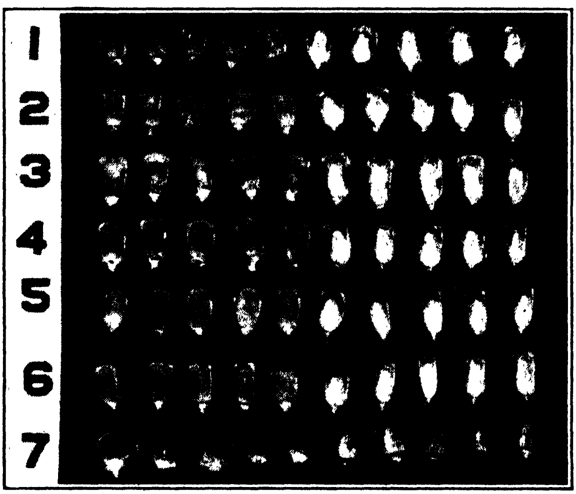

Fig. 4.—Experiment 2: 1. Woodburn; 2. K 35, immature, dried; 3. K 35, mature; 4. U. S. 13; 5. U. S. 65; 6. U. S. 65, dried; 7. Yellow flint.

In the eight trials, the pigs fed the hybrid corns ate as much corn and total feed daily a head and were ready for market 2 days later, on the average, than were those fed the open-pollinated corns. Those having the hybrid corns required an average of 2.0 per cent more feed per 100 pounds of gain than those fed the open-pollinated corns.

A summary of the five Ohio trials and two trials each at the Indiana (2, 3) and Minnesota Experiment Stations (5, 6), in which ground open-pollinated and ground hybrid corns were compared, showed average gains of 1.48 and 1.46 pounds daily a head and feed requirements per 100 pounds of gain of 386 and 388 pounds, respectively.

The relative performance on ground corn is not necessarily indicative of what it would be on shelled corn. Some have believed that, especially if they were not ground, a number of the hybrid corns were too hard for pigs to eat readily. A summary of three comparisons made by the Ohio Experiment Station and two each made by the Indiana (2, 3) and Minnesota (5, 6) Experiment Stations, in which open-pollinated and hybrid shelled corns were each fed, to a total of 80 pigs, showed gains of 1.56 and 1.55 pounds daily a head and feed requirements of 369 and 367 pounds, respectively. Two hybrid corns were fed in the Indiana and two in the Minnesota tests. In the summary, the data for the group fed the harder of the two corns were used. In each comparison the corn and the supplement were self-fed separately. There was no difference in the supplement and a difference of only 0.07 pound in the amount of corn consumed daily a head.

EXPERIMENT 3

Except that no open-pollinated variety was grown, the plan of the third experiment was the same as that of the second.

As in the second trial, the immature K35 corn was planted at the normal time but harvested early in September. When harvested it contained 48.9 per cent of moisture. Immediately after it was harvested, it was dried so that it could be kept without molding. As fed, it contained an average of 15.2 per cent of moisture. Since the amount harvested was not sufficient for 14, only 10 pigs were included in the group to which it was fed.

Moldy corn.—The U. S. 13 was grown on rather unproductive, leased land and was not planted until late. The season was so unfavorable for late planted corn that the yield was extremely low. Because of the small quantity available, only six pigs were included in the group to which it was fed.

Determinations indicated that the U. S. 13 was no higher in moisture than was that grown in 1940 and used in the first experiment. Possibly atmospheric conditions or the method of handling it were not as favorable for keeping it in good condition. It molded badly in storage.

In the two previous tests, pigs fed U. S. 13 and those fed K35 gained 1.30 and 1.25 pounds daily a head and required 405 and 406 pounds of feed per 100 pounds of gain, respectively. Considering its moldy condition, the pigs in this test that received the U. S. 13 corn made a surprisingly favorable showing. They outgained those fed the K35. The difference in the rates of gain was practically the same as in the two previous trials, when the U. S. 13 was either sound or only slightly moldy.

When both corns were sound, there was no difference in the efficiency of the gains. In this test the pigs fed the moldy U. S. 13 corn required 9.8 per cent more feed per unit of gain than those fed sound corn of the K35 variety. In both instances, the corns were reduced to an equivalent moisture basis of

5. Ferrin, E. F., and D. W. Johnson. 1941. Hybrid and Open-pollinated Corn for Hogs. Mimeo. Lft. H-78, Minn. Agr. Exp. Sta.
6. Ferrin, E. F. 1942. Hybrid and Open-pollinated Corn for Hogs. Mimeo. Lft. H-80, Minn. Agr. Exp. Sta.

15.5 per cent. At the prices used, a value 88.7 per cent as high a pound as that of the sound corn was obtained for the moldy corn.

Six-tenths of a pound more corn daily a head was charged against the pigs fed the moldy U. S. 13 than against those fed any other corn. The group took 22 per cent more supplement daily a head than the pigs fed the K35, or a sound standard corn. Usually a ration relatively high in protein produces more rapid and more efficient gains than one lower in protein. The smaller number of pigs in the group gave them more room at the feeder. This may have contributed to their greater feed consumption. Possibly some of the corn charged against the group was wasted rather than ingested. It is believed, however, that a large portion of the increased amount of feed required per unit of gain was due to the mold lowering the nutritive value of the corn rather than to the corn being wasted and not consumed.

TABLE 5.—Factors possibly affecting the feeding value of corn; Experiment 3

	1	2	3	4	5	6
	K35 Mature	**K35 Immature dried**	**U.S.65 Hard**	**U.S.65 Hard dried**	**Yellow flint Very hard**	**U.S.13 Long season moldy**
Supplement	Tankage, 19; soybean oil meal, 39; cotton seed meal, (ground alfalfa, 25; minerals, 8					
Average moisture in corn as fed, per cent	**18.81**	**15.21**	**16.93**	**11.09**	**17.96**	**21.37**
Composition, per cent:*						
Protein	7.49	7.70	7.80	8.03	10.58	8.17
Fat	1.35	1.49	1.56	1.53	1.71	1.70
Fiber	1.93	2.47	1.78	1.89	1.81	2.39
Ash	1.24	1.57	1.19	1.20	1.53	1.43
Kernels high in horny starch, per cent	43.0	....	77.0	....	....	....
Average crushing pressure, pounds	77	....	89	....	....	....
Supplement in total feed, per cent	12.7	12.1	12.6	15.0	14.0	13.6
Pigs at start	14	10	14	14	14	6
Initial weight per pig, pounds	56.7	58.2	57.9	57.0	57.6	57.4
Pigs at close	14	9	14	13	13	6
Final weight per pig, pounds	216.3	198.9	205.7	203.2	189.4	212.3
Average daily gain, pounds	**1.42**	**1.37**	**1.51**	**1.39**	**1.27**	**1.48**
Days to gain 160 pounds	113	117	107	116	126	109
Daily feed per pig, pounds:						
Shelled corn, 15.5 per cent moisture	5.04	4.91	5.09	4.85	4.56	5.67
Supplement	0.73	0.68	0.74	0.86	0.75	0.89
Total	5.77	5.59	5.83	5.71	5.31	6.56
Feed per 100 pounds gain, pounds:						
Shelled corn, 15.5 per cent moisture	353.74	359.16	337.58	349.42	358.44	384.48
Supplement	51.26	49.59	48.78	61.69	58.55	60.36
Total	**405.00**	**408.75**	**386.36**	**411.11**	**416.99**	**444.84**
Cost of feed per 100 pounds gain	$ 8.82	$ 8.88	$ 8.42	$ 9.09	$ 9.17	$ 9.75

For prices see footnote to table 1.
*On a basis of 15.5 per cent of moisture.

COMBINED DATA

Average composition.—Table 6 shows the average composition of the different corns used in the tests. To make them comparable, the analyses are on a moisture basis of 15.5 per cent. Since in 1942 the U. S. 13 was planted late and at the close of the growing season was not mature, the average analyses of the K35, U. S. 13, and U. S. 65 corns grown in 1940 and 1941 are shown in the second part of the table.

TABLE 6.—Average composition of corns; based on moisture content of 15.5 per cent

	Part 1				Part 2		
	K35 Mature	K35 Immature dried	U.S.65 Hard	Yellow flint Very hard	K35 Mature	U.S.13 Long season	U.S.65 Hard
Years	1940, 1941, and 1942				1940 and 1941		
Average moisture in corn before harvesting, per cent	....	....	....	....	29.00	29.75	24.15
Average moisture in corn at start of test, per cent	20.47	11.77	17.83	19.2	21.60	22.60	18.10
Average moisture in corn as fed, per cent	**18.96**	**14.95**	**16.98**	**18.93**	**19.03**	**21.64**	**17.01**
Composition, per cent:*							
Protein	7.94	8.82	8.21	9.51	8.16	9.02	8.42
Fat	1.44	1.20	1.13	1.23	1.48	1.34	.91
Fiber	1.90	2.73	2.69	2.88	1.96	4.81	3.14
Nitrogen-free extract	71.95	70.24	71.22	69.27	71.62	67.18	70.75
Ash	1.27	1 51	1.25	1.61	1.28	2.15	1.28
Kernels high in horny starch, per cent	43	....	84	....	....	....	....
Average crushing pressure, pounds	75	....	93	....	....	....	....

*On a basis of 15.5 per cent of moisture.

Immature dried corn.—Table 7 summarizes the results of the three tests in which mature and immature corn of the K35 variety were compared. During the early part of the experiments the pigs having the immature corn ate more corn but less supplement and made slightly faster gains but no more gain per unit of feed than those having the mature corn. During the latter part of the tests they ate a little less corn and a little less supplement daily a head and required less feed per unit of gain than those fed mature corn. Pigs on slightly less than a full feed normally require less feed per unit of gain than do similar pigs that are full fed. What portion of the difference in the feed required per unit of gain, if any, was due to the corn itself and what portion was due to other causes, such as a lowered feed intake, is not known. Immature corn that was kept from molding by drying was worth fully as much, if not more, a pound, on an equivalent moisture basis, as was mature corn.

The loss sustained on immature corn that does not spoil is in a reduced yield per acre rather than in a lowered feeding value per pound of solids of what is produced. Estimates of the yields of immature corn, if they are based on total weights and on 70 pounds to the bushel rather than on an equivalent moisture content or on the actual dry matter, are deceiving.

Tests conducted by the Agronomy Department of the Ohio Agricultural Experiment Station (7) and reported on page 38 of Special Circular 53 showed the effect of the stage of maturity on the yield of corn in grain. Beginning when the kernels were well dented or at the start of silo filling, some corn was cut and shocked every seventh day for 6 weeks. The 7-year average yields on a moisture basis of 15.5 per cent were 46.9, 50.9, 55.8, 60.5, 60.8, and 60.3 bushels per acre, respectively.

TABLE 7.—Comparison of mature and immature corn

	Growing period		Fattening period		Entire time	
	K35 Mature	**K35 Immature dried**	**K35 Mature**	**K35 Immature dried**	**K35 Mature**	**K35 Immature dried**
Average moisture in corn as fed, per cent	....	....	....	....	18.96	14.95
Supplement in total feed, per cent	15.8	13.9	9.5	9.1	12.7	11.9
Number of comparisons	3	3	3	3	3	3
Pigs at start	42	38	42	38	42	38
Initial weight per pig, pounds	60.7	62.0	129.0	135.6	60.7	62.0
Pigs at close	42	38	40	37	40	37
Final weight per pig, pounds	129.0	135.6	195.3	186.4	195.3	186.4
Average daily gain, pounds	**1.05**	1.11	**1.68**	**1.69**	**1.28**	**1.29**
Days to gain 160 pounds	....	....	....	....	125	125
Daily feed per pig, pounds:						
Shelled corn, 15.5 per cent moisture	3.41	3.71	6.39	6.17	4.48	4.47
Supplement	0.64	0.59	0.67	0.62	0.65	0.60
Total	4.05	4.30	7.06	6.79	5.13	5.07
Feed per 100 pounds gain, pounds:						
Shelled corn, 15.5 per cent moisture	325.51	334.43	379.64	365.17	351.19	346.93
Supplement	61.25	53.84	39.75	36.57	51.05	46.83
Total	**386.76**	**388.27**	**419.39**	**401.74**	**402.24**	**393.76**
Cost of feed per 100 pounds gain	$ 8.60	$ 8.53	$ 8.95	$ 8.55	$ 8.77	$ 8.54

For prices see footnote to table 1.

The yields of corn planted on different dates are given on page 36 of the same publication. The average planting dates were April 29, May 7, May 17, May 27, June 6, and June 13. The average yields when the corn was reduced to a moisture content of 15.5 per cent were 61.6, 65.2, 63.7, 57.8, 46.3, and 37.3 bushels to the acre, respectively. Corn planted June 13 yielded 26.4 bushels per acre less than that planted on May 17, or 27 days earlier.

Hard corn.—A summary of the three trials in which K35, U. S. 65, and yellow flint corns were compared is given in table 8. U. S. 65 is harder than K35 and flint corn is harder than U. S. 65. The average moisture contents of the three corns as fed were 19.0, 17.0, and 18.9 per cent, respectively.

In each of the three tests, the pigs having the U. S. 65 corn required less feed per unit of gain than those having the K35, or softer corn. In two, they also ate more feed daily a head and made more rapid gains. The summary of

7. Agronomy Department. 1938. Ohio Agr. Exp. Sta. Spec. Cir. 53: p. 38, Table 44, "Yields of Corn Cut and Shocked at Different Stages of Maturity". Page 36, Table 40, "Date of Planting Clarage Corn".

TABLE 8.—Effect of hardness on the palatability and feeding value of corn

	Growing period			Fattening period			Entire time		
	K35	U.S.65	Yellow flint	K35	U.S.65	Yellow flint	K35	U.S.65	Yellow flint
Average moisture in corn as fed, per cent	....	....	....	....	....	....	18.96	16 98	18 93
Supplement in total feed, per cent	15.8	15.0	16.6	9.3	8.9	9.6	12.2	12.1	13.0
Number of comparisons	3	3	3	3	3	3	3	3	3
Pigs at start	42	42	43	40	40	43	42	42	43
Initial weight per pig, pounds	60.7	61.6	61.2	130.6	140.8	134.1	60.7	61.6	61.2
Pigs at close	42	40	43	40	40	41	40	40	41
Final weight per pig, pounds	129.0	140.8	134.1	212.5	213.4	204.4	212.5	213.4	204.4
Average daily gain, pounds	**1.05**	1.19	1.11	1.67	**1.72**	1.60	1.31	**1.40**	1.30
Days to gain 160 pounds	....	....	....	....	....	....	123	116	124
Daily feed per pig, pounds:									
Shelled corn, 15.5 per cent moisture	3.41	3.75	3.65	6.39	6.34	6.26	4.65	4.74	4.68
Supplement	0.64	0 66	0.73	0.66	0.60	0.66	0.65	0.64	0.70
Total	4.05	4.41	4.38	7.05	6.94	6.92	5.30	5.38	5.38
Feed per 100 pounds gain, pounds:									
Shelled corn, 15.5 per cent moisture	325.51	313.69	328.17	382.01	368.16	392.21	355.63	339.49	358.94
Supplement	61.25	55.49	65.24	39.21	34.85	41.43	49.50	45.71	53.80
Total	**386.76**	**369.18**	**393.41**	**421.22**	**403.01**	**433.64**	**405.13**	**385.20**	**412.74**
Cost of feed per 100 pounds of gain	$ 8.60	$ 8.17	$ 8.79	$ 9.19	$ 8.77	$ 9.26	$ 8.80	$ 8.49	$ 9.02
Value with K35 as 100 per cent	....	106.4	97.5	....	105.4	96.6	....	106 3	97.4

For prices see footnote to table 1.

TABLE 9.—Effect of drying on the palatability and feeding value of hard corn

	Growing period			Fattening period			Entire time		
	K35	U.S.65 Hard	U.S.65 Hard Dried	K35	U.S.65 Hard	U.S.65 Hard Dried	K35	U.S.65 Hard	U.S.65 Hard Dried
Average moisture in corn as fed, per cent	....	....	....	....	....	....	18.03	16.50	10.30
Supplement in total feed, per cent	16.0	15.7	17.7	9.3	9.4	11.4	12.2	12.6	14.5
Number of comparisons	2	2	2	2	2	2	2	2	2
Pigs at start	28	28	28	28	27	26	28	28	28
Initial weight per pig, pounds	59.0	59.8	59.1	127.3	133.8	130.8	59.0	59.8	59.1
Pigs at close	28	27	26	28	27	26	28	27	26
Final weight per pig, pounds	127.3	133.8	130.8	211.6	205.2	201.5	211.6	205.2	201.5
Average daily gain, pounds	**1.16**	**1.15**	1.11	**1.72**	**1.70**	**1.55**	**1.36**	**1.37**	**1.29**
Days to gain 160 pounds	....	....	....	....	....	....	118	117	125
Daily feed per pig, pounds:									
Shelled corn, 15.5 per cent moisture	3.48	3.60	3.69	6.50	6.09	6.04	4.80	4.57	4.65
Supplement	0.67	0.67	0.79	0.67	0.63	0.77	0.67	0.66	0.78
Total	4.15	4.27	4.48	7.17	6.72	6.81	5.47	5.23	5.43
Feed per 100 pounds gain, pounds:									
Shelled corn, 15.5 per cent moisture	321.04	312.51	330 89	377.71	358.12	388.62	352.34	334 76	359 26
Supplement	61.36	58.39	71 23	38.86	37.31	49.86	48.93	48 08	60.73
Total	**382.40**	**370.90**	**402.12**	**416.57**	**395.43**	**438.48**	**401.27**	**382 84**	**419.99**
Cost of feed per 100 pounds gain	$ 8.52	$ 8.24	$ 9.05	$ 8.88	$ 8.44	$ 9.47	$ 8.72	$ 8.34	$ 9.26
Value with K35 as 100 per cent	....	104.1	92.6	....	106.1	93.0	....	105.6	93 2

For prices see footnote to table 1.

the three trials shows that they ate averages of 10.0 per cent more and 2.2 per cent less corn daily a head during the first and the latter parts of the experiments, respectively, than did those having K35 and that the advantage of the harder corn over the one that was not so hard decreased as the pigs became heavier. At the prices used, the average worth of the U. S. 65 was 6.9 per cent greater than that of the K35.

Although a higher value was obtained for a hard dent corn than for one that was not so hard, a flint, or still harder, corn did not show a still higher value. In the three trials, the average worth of the flint corn was 97.4 per cent that of the K35. During both the growing and the fattening period, the pigs fed the flint corn took more supplement than those fed the K35. The lower value obtained for the flint corn was due partially to the greater amount of supplement consumed by the pigs that received it. The summary by periods indicates that the relative effectiveness of the flint corn decreased as the pigs became heavier.

Hard dried corn.—New corn is relatively high in moisture. It usually dries some in the winter but less rapidly than it does in the spring. Moisture determinations of the corns used in the experiments were made each month. The average moisture contents of the dent corns in December, January, February, and March were 20.3, 19.5, 18.7, and 17.7 per cent, respectively. Since they were drier than the atmosphere, some moisture was absorbed by the dried corns. The data for both the dried immature corn and the dried U. S. 65 showed that in the four months, as named, they contained averages of 9.5, 10.5, 12.6, and 13.2 per cent of moisture, respectively.

Since the tests were carried on in the winter when the moisture contents of the corn were relatively high, in the second and third experiments, two groups of pigs were fed U. S. 65, or the hard dent corn. The corn for one of these two groups was dried so that its moisture content would be similar to that of corn that is not fed until summer or later. Table 9 summarizes the results of the two comparisons of U. S. 65 corn which had not been dried and which had been dried.

The pigs which had the dried corn took slightly more corn, 1.8 per cent, daily a head than those which had the undried corn. In one trial they consumed more and in the other less. In both they took more supplement daily a head. Nevertheless, they gained more slowly and made less gain per unit of feed consumed than did those having the undried corn.

The palatability test referred to earlier indicated that corns higher in moisture were less palatable than one containing approximately 16 per cent of moisture. These later tests provided no conclusive evidence as to whether hard corn averaging 16.5 per cent of moisture was more or less palatable than corn originally from the same supply which was dried and which averaged 10.3 per cent of moisture when fed.

No kernels were observed to have passed through the digestive tract whole. Possibly rather than being less digestible, the masticated particles of the dried corn were so hard that the length of time needed for their digestion was greater than the length of time it took them to pass through the digestive tract. Regardless of the explanation, in both experiments the pigs receiving the hard dried corn required more feed per unit of gain than those receiving the hard corn that was not dried. The effect of grinding or of the fineness of grinding dried hard shelled corn on the efficiency of its utilization by pigs was not studied.

Long season corn.—As previously mentioned, the U. S. 13 variety is adapted to a longer growing season than commonly prevails in Wayne County. In 1940, the U. S. 13 was planted May 21 and contained 30.3 per cent of moisture October 17 and 27.2 per cent December 17. In 1941, it was planted May 19. The late fall of 1941 was an exceptionally favorable one for the ripening of corn. Determinations indicated that on October 20, December 15, and January 17 the U. S. 13 corn contained 29.2, 18.0, and 19.4 per cent of moisture, respectively. Possibly the moisture in the December 15 sample was representative. Apparently, however, it was low. If it was representative, the U. S. 13 corn gained 1.4 in a period when the other dent corns lost an average of 0.4 per cent of moisture. The U. S. 13 was so high in moisture the first year that it molded slightly on the ear in the crib.

Table 10 summarizes the results of the first two trials comparing the long season or late maturing U. S. 13 and the K35 corns, a variety that is more nearly adapted to the locality in which it was grown. The two corns gave similar results in both the growing and fattening periods. Apparently, if it can be kept without spoiling, a long season corn is worth as much per pound of solids or dry matter contained as is an earlier maturing variety.

TABLE 10.—Comparison of a late and an earlier maturing corn for pigs

	Growing period		Fattening period		Entire time	
	K35	**U.S.13 Long Season**	**K35**	**U.S.13 Long Season**	**K35**	**U.S.13 Long Season**
Average moisture in corn as fed, per cent	....	....	....	....	19.03	21.64
Supplement in total feed, per cent	15.2	15.6	8.8	8.7	12.0	12.4
Number of comparisons	2	2	2	2	2	2
Pigs at start	28	28	26	27	28	28
Initial weight per pig, pounds	62.6	62.8	137.6	140.7	62.6	62.8
Pigs at close	28	27	26	27	26	27
Final weight per pig, pounds	134 8	140.7	210.5	204 2	210 5	204.2
Average daily gain, pounds	**1.03**	**1.11**	**1.61**	**1.64**	**1.25**	**1.30**
Days to gain 160 pounds	....	....	....	....	128	124
Daily feed per pig, pounds:						
Shelled corn, 15.5 per cent moisture	3.41	3.69	6.20	6.29	4.45	4.61
Supplement	0.61	0.68	0.60	0.59	0.61	0.65
Total	4.02	4.37	6.80	6.88	5.06	5.26
Feed per 100 pounds gain, pounds:						
Shelled corn, 15.5 per cent. moisture	330.49	333.64	384.68	382.70	356.71	355.65
Supplement	59.24	61.81	37.03	36.25	48.50	50.34
Total	**389.73**	**395.45**	**421.71**	**418.95**	**405.21**	**405.99**
Cost of feed per 100 pounds gain	$ 8.63	$ 8.78	$ 8.96	$ 8.89	$ 8.79	$ 8.83
Value with K35 as 100 per cent	....	97.9	....	100.8	....	99.5

For prices see footnote to table 1.

Protein consumption.—Since the shelled corn and the supplemental mixture were self-fed separately and the same supplemental mixture was used in each of the three experiments, the data provide information as to the rapidity of the gains, the corn and supplement required per unit of gain, and the quantity of supplement and total protein taken by self-fed pigs at different stages of the growing and fattening period. These data are presented in table 11.

A pig in lot 2 and one in lot 5 of experiment 3 were not removed from their respective groups for a short time after they became ill and began losing in weight rather than gaining. Their illness occurred during the 150 to 200-pound period. The data for these groups in this period are not included in those given in the table.

Only a few of the groups were carried beyond an average weight of 200 pounds and those that were averaged only 218 pounds when taken off feed. Their performance may not be typical of that of pigs while they are between 200 and 250 pounds in weight. If the data for this period are representative, however, they indicate that pigs self-fed shelled corn and such a supplement separately are inclined to continue to eat less supplement as they get heavier and fatter.

TABLE 11.—Protein taken by self-fed pigs
Experiments 1, 2, and 3

	Weight of Pigs			
	Under 100 pounds	100-150 pounds	150-200 pounds	Over 200 pounds
Pigs at start	248	245	217	107
Initial weight per pig, pounds	61.5	103.6	153.2	202.8
Pigs at close	245	241	217	107
Final weight per pig, pounds	103.6	152.2	204.9	218.3
Average daily gain, pounds	**1.00**	**1.36**	**1.65**	**1.63**
Daily feed per pig, pounds:				
Shelled corn, 15.5 per cent moisture	3.16	4.81	6.51	6.98
Supplement	**0.63**	**0.76**	**0.60**	**0.48**
Total	3.79	5.57	7.11	7.46
Feed per 100 pounds gain, pounds:				
Shelled corn, 15.5 per cent moisture	315.44	352.18	394.39	427.44
Supplement	63.01	55.80	36.26	29.14
Total	378.45	407.98	430.65	456.58
Parts corn to supplement	5.0:1	6.3:1	10.9:1	14.7:1
Supplement in ration, per cent	16.6	13.7	8.4	6.4
Protein in ration, per cent	**13.4**	**12.6**	**11.2**	**10.6**

Supplement=Dry rendered 60 per cent tankage, 19; toasted extracted 44 per cent soybean oil meal, 39; expeller 41 per cent cottonseed meal, 9; ground 15 per cent alfalfa, 25; minerals, 8. The corn contained an average of approximately 8.87 per cent of protein and the supplemental mixture, an average of approximately 36.0 per cent.

Smaller amounts of supplement or protein were taken than is commonly provided in mixed rations for pigs of similar weights. In the palatability test previously referred to, in which corn and a supplement of tankage, 34; expeller soybean oil meal, 34; ground alfalfa, 24; minerals, 8 were self-fed separately, the pigs took sufficient supplement to provide rations containing 14.6, 12.5, and 11.4 per cent of total protein when they were under 100, between 100 and 200, and between 200 and 280 pounds in weight, respectively. In these periods they gained 1.21, 1.47, and 1.55 pounds daily a head and required 330, 406, and 438 pounds of feed per 100 pounds of gain, respectively. The findings of this and other tests indicate that pigs having more protein than that taken by those in the tests reported in table 11 make somewhat faster and more efficient gains.

SUMMARY

Pigs preferred some corns to others. Of those tried, the less palatable corn, when it was fed separately—that is, when it was the only one available—produced practically as rapid and as efficient gains as the more palatable ones. The preferences were not for open-pollinated as against hybrid corns but apparently were influenced, directly or indirectly, by the moisture content of the corns.

Consistently, a higher value was obtained for a hard dent hybrid corn than for one that was not so hard. On an equivalent moisture basis, it showed an average worth 6.9 per cent greater a pound than the standard corn. The average amounts of moisture in the hard and softer corn as fed were 17 and 19 per cent, respectively. The advantage of the hard over the softer corn decreased as the feeding period advanced.

Flint corn which was still harder produced a trifle less, rather than more, gain per unit of feed than the standard dent hybrid corns. As with the hard hybrid, the relative effectiveness of the flint corn decreased as the pigs became heavier.

Drying hard dent hybrid corn to summer dryness, or an average of 10.3 per cent of moisture, apparently did not reduce its palatability but lowered its effectiveness or feeding value. Its average worth was 93 per cent that of the standard and 88 per cent that of the undried hard corn.

Immature corn, that was kept from molding by drying, was worth fully as much, per pound of dry matter contained, as was mature corn. The loss from late planted or immature corn, that is kept without spoiling, is in a reduced yield of grain, on a dry matter basis, per acre rather than in a lowered feeding value, per pound of dry matter produced.

On an equivalent moisture basis, except when molded, the long-season or late-maturing corn, like the immature corn, showed a feeding value a pound as high as that of the standard corn.

Freezing did not impair the nutritive value of immature corn.

Molded corn was worth 88.7 per cent as much a pound, on an equivalent moisture basis, as sound corn. Doubtless the worth of moldy corn varies with its condition.

As the pigs, which were self-fed shelled corn and supplement separately, became heavier they gained more rapidly and took less supplement in relation to the corn consumed but required more feed per unit of gain produced.

FARM AUCTION SALES

J. H. SITTERLEY AND J. I. FALCONER

The war has brought a pronounced increase in the number of farmers disposing of their chattels at auction. In 1940, before the influence of the war on agriculture had made itself felt to any extent, 857 farm auctions were advertised in 17 representative rural papers in the State during the 8 most popular sale months. By the end of 1943 the number of auctions advertised in these same papers had doubled. The first 2 months of 1944 continued to show some increase over the number advertised in the same months in previous years but not as large an increase as took place in 1943.

In 1940 relatively few large operating farms were included among those selling out. The average number of cows and bred heifers advertised was approximately eight per sale. Since then numerous large operating units have been disposed of and the average number of cows and bred heifers listed per sale has risen between 15 and 20 per cent.

A tabulation was made of the reasons for selling out as stated in the sale notice. In 1940 approximately one-third gave as the reason for their sale the indefinite statement "quitting farming." Other more definite reasons given that year were: Sold farm, 18 per cent; settling an estate, 16.8 per cent; rented farm, 8.9 per cent; ill health, 8.6 per cent; dissolving partnership and changing tenants, 6.5 per cent; and all others, 8.9 per cent. None listed shortage of labor or going to the armed services as reasons in 1940.

The past 3 years have brought numerous changes in the reasons given for selling out. A much smaller proportion is listing "quitting farming" as the cause and is listing other and more definite reasons. Thus far in 1944 the reasons given by the farmers for disposing of their livestock and equipment are as follows: Sold farm, 35.4 per cent; quitting farming, 15.4 per cent; ill health, 13.2 per cent; settling an estate 11.5 per cent; the operator or a son going into the armed services, 7.1 per cent; rented farm, 4.7 per cent; labor shortage, 4.1 per cent; and all other causes, 8.6 per cent.

In 1940 none listed "going into the armed services" as a reason for the sale; in 1942, 2.0 per cent gave this as the cause; in 1943, 3.2 per cent; and thus far in 1944, 7.1 per cent. Ill health as a reason for selling out has materially increased since 1942, which is unquestionably a reflection of the advanced age of many of the farmers in the State and the strenuous production program of the past few years. Leaving the farm for other work reached a peak in 1943 when 10.4 per cent listed this as the cause of the sale. So far in 1944 only 3.6 per cent have given this as the cause.

TABLE 1.—The number of farm auction sales advertised in 17 rural papers in Ohio for selected months in 1940, 1942, 1943, and 1944*

Month	1940	1942	1943	1944
January	102	160	189	193
February	235	228	259	270
March	158	194	213	......
August	27	55	122	......
September	58	127	177	......
October	123	247	298	......
November	108	212	259	......
December	46	128	190	......
Eight months' total	857	1351	1707	......

*Counties in which the 17 papers used in the analysis are published are: Adams, Ashtabula, Columbiana, Franklin, Harrison, Holmes, Logan, Madison, Medina, Monroe, Morgan, Morrow, Preble, Sandusky, Warren, Williams, and Van Wert.

OHIO WEATHER SUMMARY FOR 1943

J. T. McClure

Weather data gathered at the Wooster Station during 1943 constitute the 56th continuous year of these records and furnish some unique and interesting contrasts with previous records and averages for the entire period. In 10 months of 1943, temperatures were below the 56-year average and only the years 1888, 1904, 1917, and 1940 were colder. The 1943 April was the coldest on record, being 7.2 degrees below the average. June was 4.1 degrees warmer than average. Four daily temperature records were broken, March 3rd and 4th, with 0 and 1 degree above zero, respectively, as all time lows; March 31st produced an all time high of 71 degrees for this date; and 39 degrees was the lowest ever recorded for July 1st.

The year ended with a deficiency of almost 8 inches of precipitation. Ten of the 12 months were below average. May, with 2.54 inches above the average, was the wettest May in 50 years; whereas June was the driest on record, with a deficiency of 3.03 inches. Of the past 56 years, 1943 is one of the driest five. There are only 2 years on record showing less snowfall than 1943, when only 15 inches fell. In spite of a nearly normal growing season of 160 days, as determined by spring and fall frost dates, another record was established by 1943 with November 6th as an all time late date for the first killing frost.

Normally rain or snow will fall on 128 days in the year but unbrellas were called for on only 94 days in 1943. One hundred and one days were clear, as against an average number of 139. This loss of sunshine was partially compensated for by 133 partly cloudy days, compared to the average of 83. One hundred and thirty-one days were recorded as cloudy.

Climatological summary for 1943

Month	Temperature, degrees F.								Precipitation			Number of days—			
	Monthly mean	Departure from average*	Highest °F.	Highest Date	Lowest °F.	Lowest Date	Range	Greatest daily range	Average†	Departure from average	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy
Wooster, Ohio															
January	26.7	−0.8	55	24	0	20	55	26	1.59	−1.48	5.00	11	1	10	20
February	28.8	1.2	59	23	−3	15, 18	62	38	1.34	−1.05	2.00	7	8	12	8
March	34.3	−3.1	71	31	0	3	71	35	3.17	−0.25	4.00	8	10	13	8
April	41.0	−7.2	72	27	20	4	52	36	2.28	−0.73	2.50	10	8	14	8
May	57.8	−0.9	80	6	29	2	51	27	6.27	2.54	....	17	7	21	3
June	71.9	4.1	92	26	43	30	49	37	0.88	−3.03	....	3	6	20	4
July	71.3	−0.5	89	14, 17, 26	39	1	50	38	5.72	1.68	....	11	8	18	5
August	67.8	−2.0	89	1	42	19	47	35	3.44	−0.16	....	5	19	6	6
September	59.9	−3.9	90	1	32	25	58	44	1.78	−1.37	....	4	18	5	7
October	49.2	−2.7	81	12	27	20	54	44	1.70	−0.81	....	8	14	3	14
November	36.6	−3.7	72	1	20	17, 29, 30	52	36	1.19	−1.41	1.25	7	1	6	23
December	27.4	−3.1	54	2	0	15, 24	54	30	0.67	−1.92	0.25	3	1	5	25
Annual	47.7	−1.9	92	June 26	−3	Feb. 15, 18	95	44	30.03	−7.99	15.00	94	101	133	131

*Years of record for Wooster, 56.
†Totals given for Wooster.
‡Data for Ohio furnished by Geo. W. Mindling, Section Director of the U. S. Weather Bureau at Columbus, Ohio.

Climatological summary for 1943.—Continued

Month	Temperature, degrees F.								Precipitation			Number of days—			
	Monthly mean	Departure from average*	Highest °F.	Highest Date	Lowest °F.	Lowest Date	Range	Greatest daily range	Average†	Departure from average	Average snowfall	With 0.01 in. or more precipitation	Clear	Partly cloudy	Cloudy
For Ohio															
January	29.5	1.0	78	24	—13	20	91	....	1.80	—1.22	7.9	13	5	6	20
February	32.1	2.7	73	23	—13	15	86	....	1.68	—0.91	2.9	10	10	8	10
March	37.3	—1.5	82	31	—13	8	95	....	4.44	1.05	4.7	9	13	8	10
April	45.9	—3.9	81	27	11	15	70	....	3.12	—0.05	1.4	14	10	8	12
May	61.2	0.6	93	6	22	22	71	....	6.39	2.68	T	19	6	10	15
June	74.7	5.0	99	{24, 25, 27}	40	30	59	....	3.37	—0.53	0	9	14	12	4
July	74.2	0.5	97	{17, 28}	38	1	59	....	6.01	2.17	0	12	12	13	6
August	72.4	0.7	101	14	40	19	61	....	2.88	—0.51	0	7	16	10	5
September	62.5	—3.1	100	1	30	{18, 26}	70	....	1.83	—1.09	0	7	15	9	6
October	52.2	—1.4	87	{1, 11}	24	20	63	....	1.76	—0.78	T	9	14	6	11
November	39.4	—2.1	84	1	9	28	75	....	1.23	—1.45	1.2	9	9	7	14
December	29.4	—2.3	63	2‡	—10	15	73	....	1.03	—1.68	2.2	6	10	8	13
Annual	50.9	—0.3	101	Aug. 14	—13	Jan. 20, Feb. 15, Mar. 8	114	....	35.54	—2.33	20.3	124	133	107	125

*Years of record for Wooster, 56.
†Totals given for Wooster.
‡Data for Ohio furnished by Geo. W. Mindling, Section Director of the U. S. Weather Bureau at Columbus, Ohio.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

Cash income to the Ohio farm in 1943 was 20 per cent above that of 1942. Prices received by the Ohio farmer in January and February of 1944 were lower than those received in any of the last 9 months of 1943.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U.S.	Ohio industrial pay rolls 1935-1939 = 100*	Prices paid by farmers	Farm products prices U.S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	......	101	101	104	100	105	101
1914	99	......	100	101	102	102	105	109
1915	102	......	105	98	103	107	106	112
1916	125	......	124	118	113	113	121	123
1917	172	......	149	175	140	119	182	201
1918	192	......	176	202	175	131	203	243
1919	202	......	202	213	204	135	218	270
1920	225	......	201	211	236	159	212	230
1921	142	......	152	125	164	134	132	134
1922	141	......	149	132	145	124	127	133
1923	147		152	142	160	122	134	147
1924	143	......	152	143	165	118	133	150
1925	151	......	156	156	165	110	159	180
1926	146	......	155	145	170	105	155	183
1927	139	......	153	139	173	99	147	171
1928	141	......	155	149	169	96	154	163
1929	139	......	154	146	169	94	151	172
1930	126	......	146	126	154	90	128	142
1931	107	84	126	87	120	82	89	105
1932	95	58	108	65	92	70	63	77
1933	96	61	108	70	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	108	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	121	118	75	128	164
1938	115	87	123	95	117	74	103	145
1939	113	103	121	93	117	76	95	146
1940	114	117	122	98	116	77	99	148
1941	127	170	131	122	138	80	121	199
1942	144	227	154	157	173	89	157	266
1943	150	......	164	192	216	97	190	319
1943								
January	149	268	158	182	196	......	174	283
February	149	275	160	178	......	......	177	261
March	150	282	161	182	......	97	181	287
April	151	284	162	185	212	......	190	296
May	152	289	163	187	......	......	197	318
June	151	293	164	190	221	......	193	317
July	150	291	165	188	229	......	192	322
August	150	298	165	193	......	......	198	307
September	150	301	165	192	......	......	194	307
October	150	311	166	192	228	......	194	374
November	150	312	167	192	......	......	193	405
December	150	......	169	196	......	......	195	352
1944								
January	150	......	169	196	229	......	187	318
February	151	......	170	195	......	......	187	301

*SOURCE: Bureau of Business Research, The Ohio State University.

ERRATUM

Page 4, paragraph 4, Ohio Experiment Station Bimonthly Bulletin No. 226, January-February, 1944

In an article entitled "Placing a value on silage", which appeared in the January-February 1944 issue of the Ohio Agricultural Experiment Station Bimonthly Bulletin, pages 3-9, the results obtained in a previous experiment, published in Bulletin 369, were referred to in calculating the value of corn silage. Clarage corn was credited with yielding 10.3 tons of silage per acre, containing 40.6 per cent or 812 pounds of dry grain per ton; whereas Blue Ridge, a larger later variety, was credited with a 12-ton yield, containing 25.3 per cent or 506 pounds per ton.

It has come to our attention that these figures imply an acre yield of 145 bushels of dry grain in one case and a somewhat smaller, though still prodigious, yield for the other variety. The figures are clearly in error.

It develops, that in referring to the older publication, figures which reported the per cent of dry grain in the total dry matter were taken as meaning per cent of dry grain in the entire crop.

The figures for dry grain per ton of silage should have been 258.2 pounds for the Clarage and 174.3 pounds for the Blue Ridge variety, or an acre yield of 47.5 and 37.2 bushels, respectively.

Naturally these corrections have a marked effect on the value of silage as calculated from the average grain content, the first method given. The average dry grain content per ton of these silages was 216 pounds, or slightly less than 4 bushels, but the grain content of the grain variety is well over 4 bushels. The actual weight of the wet grain in the silage was probably about three times as much as the dry grain weight, or 648 pounds per ton—leaving approximately 1352 pounds of moist roughage which may be considered equal in dry weight and value to one-third this amount of common hay (450 pounds or .225 ton).

The value of a ton of silage from well-eared corn by this method may thus be considered to equal the value of 4 bushels of shelled corn, plus the value of .225 ton of common hay.

Computation of the value of silage by the other methods cited in the article, "Placing a value on silage," are unaffected by this error.

BIMONTHLY BULLETIN

VOL. XXIX JULY-AUGUST, 1944 NO. 229

YOUR FRIENDS THE AUTHORS

Bimonthly Bulletin readers are already friends with the authors of this issue. You may renew your acquaintance by referring to the pictures in the three previous issues for 1944.

The cover photograph shows the poultry range at the Ohio Agricultural Experiment Station, Wooster, Ohio. The picture was taken by Harry G. Binau, formerly the Experiment Station photographer, now of the United States Army.

CONTENTS

AN EXPERIENCE WITH FEATHER PICKING AND CANNIBALISM OF PULLET LAYERS

D. C. KENNARD AND V. D. CHAMBERLIN

The causes of feather picking and cannibalism in pullet layers are innumerable. The conditions under which chickens are confined indoors, in contrast to those conditions existing when they are out of doors on good pasturage, are generally responsible. Idleness, discontent, overcrowding, filthy floor litter, high temperature, faulty ventilation, and dietary deficiencies are the most frequent causes or contributing factors to the vices of feather picking and cannibalism.

Although conditions can hardly be made as favorable for the contentment of chickens confined indoors as when they can be out of doors on good pasturage, nevertheless, much can be done towards effective prevention or control of feather picking and cannibalism when chickens are confined indoors. The purpose of this article is to discuss some of the results of feeding and management experiments recently carried on with 420 Rhode Island Red pullet layers at the Station's poultry plant.

In this experiment, six groups of 70 early-June hatched Rhode Island Red pullets were housed on the third floor of the service building in quarters similar to those of pullet layers housed in barns or other buildings. These pullets had plenty of room, the floor litter was in good condition, and there was ample ventilation. On the other hand, the ration and method of feeding were conducive to feather picking and cannibalism. The ration consisted of a 16.4 per cent protein mash and the free choice of whole corn. Despite the fact that the mash was low in protein and contained 50 per cent corn and oats, between December 16, 1943 and February 16, 1944 the pullets consumed 63 per cent whole corn and 37 per cent mash, or a total protein intake of only 11.7 per cent of the total feed intake.

The pullets started to lay the first part of December; there followed an average egg production of 28 per cent between December 16 and February 16. The egg production like the vices of feather picking and cannibalism (as will be noted later), was a direct result of the ration and the method of feeding. This was a definite example of a failure of Rhode Island Red pullet layers to balance their ration properly when given free choice of whole corn and a low-protein mash. Presumably it should not have been expected that these pullets would have properly balanced their ration when offered such a low-protein mash with the free choice of whole corn, since this would have necessitated their consumption of whole corn and mash in the reverse proportion—that is, 65 per cent mash and 35 per cent whole corn. This would have meant a severe restriction of the consumption of whole corn, which is greatly relished by Rhode Island Red pullets.

FEATHER PICKING AND CANNIBALISM

The latter part of December the pullets began feather picking. The condition grew progressively worse, so that in January the birds were badly deplumed about their necks, breasts, backs, in front of tails, and around their abdomens. As so often happens, feather picking was followed by cannibalism, with a resultant loss of 45 birds from January 1 to February 16. On the latter date, the free-choice feeding of whole corn was discontinued, the pens were darkened, and all the pullets were debeaked. Since these measures were taken there has been no further trouble from feather picking and cannibalism to date (June 1).

It should be emphasized here that merely clipping or cutting the upper beaks is not sufficient. To be effective it is necessary to remove the upper beaks by means of the special tearing process[1] discovered by this Station some years ago. In this way a much larger part of the upper beak can be removed without causing bleeding and injury to the birds. The beaks can be removed at the rate of 200 per hour, and, if properly done, no loss of egg production needs to follow.

It should be further noted that feather picking and cannibalism took place in all groups despite the fact that one group received the mash mixture which included 30 per cent oats, a second group received the mash with 40 per cent oats, a third group received corn and cob meal instead of ground corn, and a fourth group received steeped alfalfa. There are times when these variations in rations may prove effective in the prevention and control of feather picking and cannibalism. However, when pullet layers, confined indoors, consume too much whole grain and too little of the high-protein, mineral, and vitamin ingredients of the mash (as may happen in the free-choice feeding of whole corn or wheat) the only remedy is to discontinue the feeding of whole corn and continue the 16.4 per cent protein mash mixture. In this case, since the habit of feather picking had become so firmly established, it was also necessary to darken the pens and remove the upper beaks of all the pullets. When preventive or control measures are taken at the beginning of the trouble, the problem of control or remedy is less difficult.

As previously stated, the ration and method of feeding were invitations to feather picking and cannibalism. Nevertheless, many laying flocks are fed and managed in much the same way, either from necessity (when only low-protein mashes are available) or by design (since low-protein mashes and high-grain rations cost less).

When mash mixtures containing 15 to 17 per cent protein are fed to layers confined indoors no additional grain should be fed if low egg production and the vices of feather picking and cannibalism are to be avoided.

When the all-mash method of feeding came into use 20 years ago, poultrymen soon observed a reduced tendency toward feather picking and cannibalism among the birds fed all-mash.

The disadvantages of free-choice feeding of whole corn or wheat together with a 20 to 24 per cent protein mash, for pullets were also observed in connection with 6 years of experiments with rations and methods of feeding White Leghorns and Rhode Island Red pullet layers at the Ohio Station. In these experiments a whole oats-mash, complete all-in-one, feed mixture (whole

[1]Described and illustrated in the Station's Bimonthly Bulletins: January-February, 1937, Number 184 and September-October, 1943, Number 224.

corn or wheat or barley can also be included) proved the most satisfactory for egg production and for the prevention or control of feather picking and cannibalism. This type of ration and method of feeding really combine the advantages of the all-mash and whole grain and mash methods of feeding and may avoid the liabilities that sometimes attend the free-choice feeding of whole grain. This is particularly true in the case of feather picking and cannibalism among pullets, in the feeding of hens, and also in the feeding of breeders, whose requirements of certain mash ingredients are more exacting for the production of hatching eggs than for market eggs.

The free-choice feeding of whole grain and a 20 to 26 per cent protein mash has become a favored method of feeding by many poultrymen. In many instances, layers do properly balance their intake of whole grain and mash. Poultrymen who secure satisfactory egg production and good hatchability of eggs and those whose flocks are not troubled with the vices of feather picking and cannibalism may well continue the free-choice feeding of whole grain and mash. This type of ration and method of feeding, like all others, has its advantages and disadvantages. The purpose of this discussion has been to call attention to some of the disadvantages and limitations that may sometimes attend the free-choice feeding of whole grain to layers.

PROGRESS REPORT ON CATALPA FENCE POST TEST

ROBERT R. PATON

During the month of February 1934, a line of 51 catalpa posts were set along a roadway in the Wooster Arboretum. These posts were nearly uniform in size, 4 to 5 inches in diameter, and all had been cut and stacked for about a year, with the exception of 15 which had been cut just previous to placing in the ground.

Soil and moisture conditions are apparently uniform throughout the entire line and no disturbance of the soil or posts has taken place. The posts do not support a fence and they are about 2 feet tall above the ground line.

At the end of the tenth summer season, eight of these posts were dug out carefully so as not to lose any of the decayed wood. Four were taken from the seasoned group of posts and four from those set green.

Each post was sawed into blocks, the cuts being made 6 inches above ground and 6, 12, and 18 inches below the ground line.

Examination of the posts showed that, with only two exceptions, they were to a high degree still sound. One post showed excessive decay with approximately only 50 per cent of the diameter still sound at 6 and 12 inches below the ground and 80 per cent sound at 18 inches below the ground. At the ground level, approximately 90 per cent of the diameter was still sound.

This post and two others were cut from the upper part of the trees, while the other five were butt posts. One of the other two upper-cut posts also showed more than average decay. At the ground line and 6 inches below ground line, 90 per cent of the diameter was still sound; at 12 inches, 60 per cent was sound; and at 18 inches, 70 per cent was sound. The other upper-cut post was over 90 per cent sound at all levels.

The balance of the posts showed a very low rate of decay, being 90 per cent sound or over, at all levels. In these posts, for the most part, decay followed the annual rings almost perfectly, and in most instances 1, 2, or 3 rings were completely missing on the sections below the ground line.

These posts were all taken from a catalpa planting in the Wooster Arboretum and were from relatively slow growing trees. The greatest diameter of the posts removed at this time was 5.5 inches, while the others were between 4.2 inches and 4.8 inches. The plot from which the trees were cut was 28 years old at the time of cutting.

There was no discernible difference between the seasoned and green posts. The two which showed the greatest decay were both seasoned posts, but the other two seasoned posts showed only slight decay.

Crumley[1] states that he found that catalpa posts which were cut from slow-growing trees were more durable than those from fast-growing trees. He found that this was true also where posts were cut from trees which might have grown rapidly for the first years but grew slowly for the years just preceding cutting. On such posts, where unsplit, there is a layer of slow growth in contact with the soil.

Crumley found also that seasoning the posts before setting did not seem to have any marked effect on durability.

CONCLUSIONS

Based on the present results, slow-growing, hardy catalpa trees should produce posts which will last well over 10 years in moderately well-drained, upland ground.

[1]Crumley, J. J. 1910. The relative durability of post timbers. Ohio Agricultural Experiment Station, Bulletin 219.

LIGHT AND HEAVY PRUNING, COMPARED WITH NO PRUNING, OF APPLES

C. W. ELLENWOOD AND T. E. FOWLER

In 1916 an orchard consisting of 112 trees was planted at the Experiment Station, Wooster, to be used in studying the effects of different types and degrees of pruning. There were seven plots at the outset of the experiment. The pruning treatments were as follows:

1—Not pruned.
2—Light dormant pruning.
3—Heavy dormant pruning.
4—Light summer pruning.
5—Heavy summer pruning.
6—Light dormant pruning, followed by light summer pruning.
7—Heavy dormant pruning, with heavy heading back in summer.

The varieties as originally planted were Baldwin, Stayman Winesap, Black Ben, and Wilson Red June. At the end of the thirteenth season, the Black Ben and Wilson Red June trees were removed, leaving Baldwin and Stayman Winesap trees standing 24 × 32 feet apart. At the end of 1937, plots 4, 5, 6, and 7 were removed, and finally at the end of 1943 the remaining trees were removed. The following data and observations refer mainly to plots 1, 2, and 3.

RESULTS

The yields, color, and size of fruit on plots 4 and 5 were so similar to the results secured from the dormant pruning that it is not considered of value to present data from these plots in this report. Plots 6 and 7, which entailed a combination of dormant and summer pruning, gave no better results than were secured from plots 2 and 3. Moreover, there were certain practical objections to either summer pruning or to a combination of dormant and summer pruning, particularly after the trees came into bearing. Not only was it more difficult for the operator to see which limbs should be removed, but a great deal of fruit was unavoidably removed in the process of pruning. It was clearly demonstrated that neither the summer-pruned nor the combination of dormant summer pruning was superior to dormant pruning. However, it is of equal importance to note that no ill effects to the trees were observed from summer pruning. This suggests that, where circumstances prevent pruning during the dormant period, the work can be done during the summer period with no injurious effects other than the accidental removal of some fruit.

HEAVY AND LIGHT PRUNING DEFINED

The terms "heavy" and "light" pruning are used in a relative sense, rather than as a mathematical measurement of the amount of wood removed by pruning. In the heavy-pruned plots an effort was made to remove considerably more wood than would be done normally. This was particularly true in the earlier years. The heavy-pruned trees actually appeared much less dense than the light-pruned trees.

TABLE 1.—Weight of brush removed from light- and heavy-pruned Baldwin and Stayman Winesap apples

Plot	Variety	Average annual weight of brush removed from 7th to 15th years from planting	Average annual weight of brush removed from 16th to 25th years from planting
		Pounds	*Pounds*
Light pruning	Baldwin	15.8	31.9
Heavy pruning	Baldwin	18.6	54.2
Light pruning	Stayman Winesap	17.8	30.1
Heavy pruning	Stayman Winesap	17.9	55.9

After the first few years, the actual amount of wood removed from the heavy-pruned trees was not so much greater than that taken from the more lightly pruned trees, as might have been expected (see table 1). The general effect of the heavy pruning during the early years was dwarfing, from which the trees did not recover.

Fig. 1.—Close up of unpruned tree at end of 28 years. Note brush under tree, the effect of self-pruning.

SIZE OF TREES

The influence of the different types of pruning on the size of the trees is shown in table 2. Three indices of size are used:

1. The circumference of the tree; the circumference in inches of each tree was taken at intervals during the course of the experiment. The measurement was made at a location 12 inches above the ground.
2. The height of the tree; in the case of the pruned trees this measurement was naturally modified by the degree of pruning.

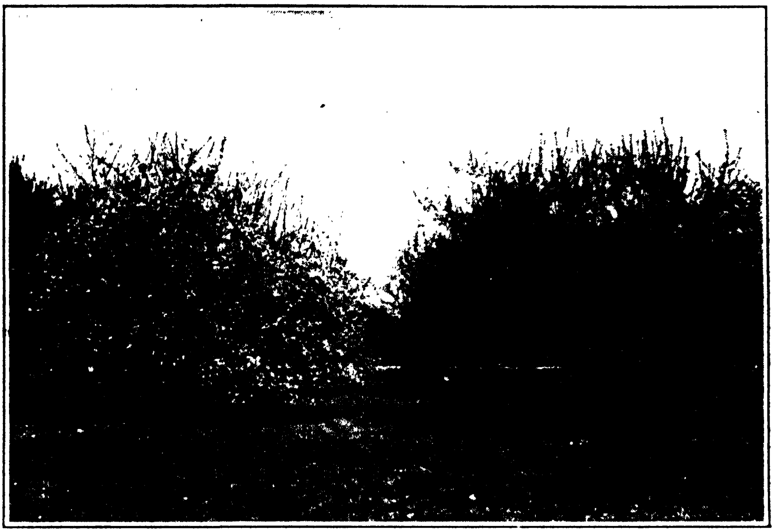

Fig. 2.—Heavily pruned trees at end of 20th year.

3. The diameter of the head of the tree; the diameters shown in table 2 are based on the average of two measurements—(a) north and south and (b) east and west.

The diameters of the trees at the end of the experiment are probably not very significant, since the distances between the trees north and south was only 24 feet and all of the trees except the heavily pruned Stayman Winesap were interlacing in that direction.

TABLE 2.—Effect of pruning on size of trees

Baldwin and Stayman Winesap. Trees planted in 1916

Variety	Index of growth	Year	Not pruned	Light pruned	Heavy pruned
Baldwin	Circumference of trunk, in inches	1925 1932 1937 1943	19.3 32.6 43.9 48.3	17.7 28.8 36.3 43.1	16.0 27.5 36.2 42.7
Baldwin	Diameter of head of tree, in feet	1937 1943	28.7 29.3	25.0 26.5	24.4 24.6
Baldwin	Height of tree, in feet	1937 1943	21.7 24.9	21.8 25.2	20.5 20.7
Stayman Winesap	Circumference of trunk, in inches	1925 1932 1937 1943	17.1 27.1 34.2 41.5	18.6 27.5 34.4 39.2	16.1 24.7 31.2 38.2
Stayman Winesap	Diameter of head of tree, in feet	1937 1943	24.4 24.6	24.5 26.6	21.3 22.5
Stayman Winesap	Height of tree, in feet	1937 1943	22.5 26.5	22.2 23.8	20.0 19.0

The girth of the unpruned Baldwin trees at the end of the period was definitely greater than the pruned trees. Unpruned Stayman Winesap trees were also larger than the pruned. The dwarfing effect of pruning was more manifest in the circumference of the trunk than in either of the other size-of-tree indices used. This dwarfing effect was more noticeable with Baldwin than with Stayman Winesap.

INFLUENCE OF PRUNING ON YIELD OF FRUIT

The average yield per tree of the three plots for the 20 years 1923-1942 is shown in table 3. It will be noted that during the first half of this 20-year period, or from the 8th to the 17th years from planting, pruning in any degree materially reduced the yield per tree of Baldwin and to a much lesser extent that of Stayman Winesap. During the second half of the 20-year period, the yield of Baldwin was appreciably reduced, even by the lighter degree of pruning. However, the lightly pruned trees of Stayman Winesap actually produced more pounds of fruit than the unpruned plot during the period from the

TABLE 3.—Effect of pruning on yield of fruit

Baldwin and Stayman Winesap. Trees planted in 1916

Plot	Average annual yield per tree, 1923 to 1932		Average annual yield per tree, 1933 to 1942		Average annual yield per tree, 1923 to 1942	
	Baldwin	Stayman Winesap	Baldwin	Stayman Winesap	Baldwin	Stayman Winesap
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Not pruned	159.7	175.7	616.6	553.4	388.1	364.6
Light pruned	103.2	168.6	482.6	614.4	292.9	391.5
Heavy pruned	91.2	134.1	439.7	467.2	265.5	300.6

Fig. 3.—Unpruned trees at end of 20th year.

18th to 27th years, but during this same period the heavy-pruned plot of Stayman Winesap produced appreciably less total weight per tree than the unpruned trees. This demonstrates that with pruning, as with other cultural practices, the influence of the variety factor is an important consideration.

SIZE OF FRUIT

The size and color of the fruit, particularly as the trees grow older, are important factors in determining the value of the fruit. Size and color grades on the fruit produced in this orchard were recorded for a 12-year period from 1929 to 1940. From table 4 it will be noted that the size of the fruit of both

Fig. 4.—Heavily pruned trees at end of 28th year.

TABLE 4.—Effect of pruning on size of fruit, 1929-1940

Baldwin and Stayman Winesap

Period	Treatment	Baldwin: Above 2¾ inches	Baldwin: 2¼ to 2¾ inches	Baldwin: Below 2¼ inches	Stayman Winesap: Above 2¾ inches	Stayman Winesap: 2¼ to 2¾ inches	Stayman Winesap: Below 2¼ inches
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1929-34...	No pruning	75.7	20.5	3.8	73.6	24.7	1.7
1935-40...	No pruning	58.6	31.2	10.2	31.6	52.4	16.0
1929-40...	No pruning	65.2	27.1	7.7	46.5	42.6	10.9
1929-34...	Light pruning	80.0	19.4	0.6	89.8	9.4	0.8
1935-40...	Light pruning	64.9	29.7	5.4	52.4	42.8	4.8
1929-40...	Light pruning	70.3	26.0	3.7	64.9	31.6	3.5
1929-34...	Heavy pruning	87.7	11.8	0.5	92.4	7.5	0.1
1935-40...	Heavy pruning	80.3	18.7	1.0	62.7	35.3	2.0
1929-40...	Heavy pruning	83.3	15.9	0.8	73.4	25.3	1.3
1929-40...	No pruning	65.2	27.1	7.7	46.5	42.6	10.9
1929-40...	Light pruning	70.3	26.0	3.7	64.9	31.6	3.5
1929-40...	Heavy pruning	83.3	15.9	0.8	73.4	25.3	1.3

Baldwin and Stayman Winesap improved in direct relation to the degree of pruning given the trees. These data also show that pruning had more influence on the size of Stayman Winesap than on Baldwin. Regardless of the amount of pruning given, the size of the fruit tended to decrease appreciably as the trees grew older.

COLOR OF FRUIT

The color of the fruit for the 12-year period is shown in table 5. Pruning had much greater influence on the color of Baldwin than on Stayman Winesap. However, with both varieties, the age of the tree had more influence on color than did pruning. During the second of the two 6-year periods, color, particularly on Baldwin, was much poorer than during the first period. Not only were there fewer apples in the above 33 per cent grade, but the percentage of fruit in the grade below 15 per cent color had materially increased during the later years.

TABLE 5.—Effect of pruning on color of fruit, 1929-1940

Baldwin and Stayman Winesap

Period	Treatment	Baldwin			Stayman Winesap		
		Above 33 per cent	15 to 33 per cent	Below 15 per cent	Above 33 per cent	15 to 33 per cent	Below 15 per cent
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
1929-34...	No pruning	68 8	20.7	10.5	89.0	7.8	3.2
1935-40...	No pruning	42.2	25.1	32 7	69.9	16.9	13.2
1929-40...	No pruning	57.4	23.6	25.0	77 4	13.3	9.3
1929-34...	Light pruning	83.3	10.6	6.1	89.2	8.2	2.6
1935-40...	Light pruning	56.7	20.3	23.0	71.6	16.8	11.6
1929-40...	Light pruning	65.9	16 9	17 2	77 6	13.9	8.5
1929-34...	Heavy pruning	90.0	6.4	3.6	84 9	12 1	3.0
1935-40...	Heavy pruning	65.1	16 5	18.4	77 6	13 7	8.7
1929-40...	Heavy pruning	74.7	12 6	12 7	80 3	13 1	6.6
1929-40...	No pruning	51.4	23 6	25.0	77.4	13.3	9.3
1929-40...	Light pruning	65.9	16.9	17.2	77.6	13.9	8.5
1929-40...	Heavy pruning	74.7	12.6	12 7	80.3	13.1	6.6

REGULARITY OF BEARING

There is nothing in the yield records over the 20-year period to suggest that pruning tended to make for more regularity of annual production. Stayman Winesap naturally has a tendency towards annual production, but Baldwin is more likely to be biennial in its bearing habits. Neither heavy pruning nor light pruning seemed to influence the annual bearing characteristics of either variety.

COLOR AND SIZE OF APPLES FROM DIFFERENT AREAS OF UNPRUNED TREES

It has been observed that the fruit from the tops and outer perimeter of the trees, particularly on older trees, is generally larger and of better color than that from the lower limbs and inside the tree. Over a period of several years the unpruned trees were divided into three sections and picked as follows: (a) the lower section of the tree up to a vertical height of 8 feet was

picked first and designated "lower section"; (b) the top of the tree was next picked and designated "top section"; (c) finally the inside of the tree was picked and the fruit labeled "inside section." The data from these observations made of the graded fruit are presented in table 6.

TABLE 6.—Color and size of apples from different areas of unpruned trees

Baldwin (average for 1938 and 1940). Stayman Winesap (average for 1938, 1939, and 1940)

Variety	Pruning treatment	Size grade			Color grade		
		Above 2¾ inches	2¼ to 2¾ inches	Below 2¼ inches	Above 33 per cent	15 to 33 per cent	Below 15 per cent
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Baldwin	Not pruned, Lower section	32.2	61.1	6.7	37.5	24.1	38.4
Baldwin	Not pruned, Top section	63.2	27.7	9.1	42.3	42.7	15.0
Baldwin	Not pruned, Inside section	21.5	59.5	19.0	26.1	17.0	56.9
Baldwin	Light pruned, (whole plot)	46.0	47.6	6.4	54.4	21.5	24.1
Baldwin	Heavy pruned, (whole plot)	82.8	16.3	0.9	64.7	17.4	17.9
Stayman Winesap	Not pruned, Lower section	11.9	54.9	33.2	54.6	26.3	19.1
Stayman Winesap	Not pruned, Top section	24.8	57.9	17.3	76.0	15.7	8.3
Stayman Winesap	Not pruned, Inside section	2.9	47.7	49.4	36.0	30.4	33.6
Stayman Winesap	Light pruned, (whole plot)	38.7	54.4	6.9	75.3	14.2	10.5
Stayman Winesap	Heavy pruned, (whole plot)	51.0	45.9	3.1	79.1	13.0	7.9

It will be noted that both size and color were appreciably better in the top section of the tree than from the bottom or inside. Thinwood pruning, wherein the unproductive weak growth from inside the tree is removed with a minimum of pruning in the top and outside branches, is based on the assumption that the fruit produced in the interior of the tree is inferior. The data shown in table 6 support this thesis. As the unpruned trees increased in age, the entire crop of fruit from these trees gradually became more and more deficient in both size and color. This was especially noticeable in the size of the Stayman Winesap.

VALUE OF FRUIT

The value of the fruit produced over an 8-year period from 1933 to 1940 is shown in table 7. The value of the fruit is based on a fair average price for apples graded into three grades. Two cents per pound was allowed for the No. 1 grade, 1¼ cents per pound for the No. 2 grade, and ¾ cent per pound for the culls. These prices do not take into consideration packages. All the fruit having 33 per cent or more color and above 2¼ inches in size was placed

Fig. 5.—Unpruned trees at end of 28th year.

in the No. 1 grade; the fruit ranging from 15 to 33 per cent color and above 2¼ inches was placed in the No. 2 grade, and all the fruit having less than 15 per cent color and all the fruit less than 2¼ inches in size was placed in the cull grade.

No consideration is here given to cost of pruning nor to the time required in picking the different plots.

TABLE 7.—**Effect of pruning on value of fruit per tree**

Baldwin and Stayman Winesap. Eight-year average, 1933-1940

Variety	Treatment	Commercial grade			Value of fruit per 100 pounds	Average annual yield per tree	Average annual value of apples per tree
		No. 1	No. 2	Culls			
		Per cent	*Per cent*	*Per cent*	*Dollars*	*Pounds*	*Dollars*
Baldwin.......	Not pruned	43	22	35	1.39	605	8.41
Baldwin.......	Light pruned	59	17	24	1.57	468	7.35
Baldwin.......	Heavy pruned	67	13	20	1.66	408	6.77
Stayman Winesap.....	Not pruned	68	13	19	1.66	555	9.21
Stayman Winesap.....	Light pruned	73	15	12	1.74	586	10.20
Stayman Winesap.....	Heavy pruned	77	14	9	1.78	452	8.04

It should be borne in mind that both Baldwin and Stayman Winesap are fairly good-sized varieties, and it might be expected that the value of the fruit per tree in the different plots would have been different had the varieties been characteristically smaller in size, like Jonathan and Grimes Golden. Moreover, the data in table 7 were computed from the yield and grade records of the trees from the 18th to the 25th years. As already pointed out, size and color were gradually decreasing as the trees grew older.

The data in table 7 show that the value of the apples from the unpruned Baldwin plot exceeded that from either the light or heavily pruned plots. The value of the fruit from the lightly pruned Stayman Winesap trees was greater than that from the unpruned plot. The value of the fruit from the heavily pruned plot with both varieties was appreciably less than the unpruned plot. The authors desire to suggest that caution be used in interpreting these data. However, in periods when labor is scarce it is felt that these figures do indicate that no great financial loss will be suffered if the amount of pruning customarily practiced by many growers is reduced or even omitted for a few years.

Any pruning practice should always be related to the fruit-bearing characteristics of the variety and also to the age of the trees.

Up until the end of the 25th year, effective spraying could be accomplished in the unpruned trees but by this time self-pruning was beginning to be in evidence on these trees. This is shown in figure 1.

SUMMARY

Data on the effect of light and heavy pruning on the size of tree and on the size and color of fruit of Baldwin and Stayman Winesap apples are presented.

Pruning in any degree appreciably reduced the yield of Baldwin. The yield from the light-pruned Stayman Winesap trees was slightly greater than from the unpruned trees.

The apples from the unpruned trees, particularly in the later years of the experiment, were smaller than from the pruned trees. The size of the Stayman Winesap was more adversely affected by lack of pruning than was true with Baldwin.

The color of fruit on the pruned trees of both varieties was better than on that from the unpruned trees, but differences were greater with Baldwin than Stayman Winesap.

The varieties under observation are naturally fairly large fruited sorts and care should be used in interpreting these results.

Variety characteristics are an important consideration in determining pruning practices.

FEED SALES IN OHIO

J. I. FALCONER

A report of feed sales in Ohio has been received annually since 1929 from feed manufacturers by the Department of Rural Economics. A comparison of these sales for the past 3 years is given in table 1. The year 1943 showed an increase of 26 per cent in volume of sales over 1942. Mixed feed sales increased by 47 per cent, while unmixed feeds showed a slight decrease.

TABLE 1.—Estimated total tons and per cent change of commercial feeds reaching the retail trade in Ohio, 1941-1943

Feed	Estimated tons			Per cent change, 1942 to 1943
	1941	1942	1943	
Mixed Feeds				
Dairy feeds	99,474	117,797	170,805	45% more
Poultry feeds	204,044	248,730	363,146	46% more
Hog feeds	61,963	85,373	130,621	53% more
Other mixed feeds	35,927	38,208	53,727	41% more
Total mixed feeds	401,408	490,108	718,299	47% more
Unmixed Feeds				
Soybean meal	77,657	68,082	46,977	31% less
Cottonseed meal	8,805	10,525	6,620	37% less
Linseed oil meal	38,120	41,745	40,910	2% less
Bran	48,876	50,298	56,569	12% more
Middlings	49,961	52,169	58,603	12% more
Alfalfa meal	5,579	5,478	3,615	33% less
Gluten feeds	23,168	26,550	18,850	29% less
Hominy	30,806	29,531	40,162	36% more
Tankage	10,451	8,146	4,887	40% less
Meat scraps	14,084	12,756	9,822	23% less
Fish meal	1,526	1,389	706	49% less
Milk products	3,512	3,504	3,644	4% more
Other	41,571	43,134	56,374	31% more
Total unmixed feeds	354,116	353,307	347,739	1.6% less
Total (all feeds)	755,524	843,415	1,066,038	26% more

Year	Total tonnage	Year	Total tonnage
1929	668,333	1937	529,788
1930	566,079	1938	570,179
1931	410,104	1939	598,785
1932	289,821	1940	650,195
1933	369,591	1941	755,524
1934	371,439	1942	843,415
1935	410,737	1943	1,066,038
1936	514,553		

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

Ohio farm wage rates have more than doubled since 1939. There has been little change in the general price level during the past year.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	...	101	102	104	100	105	101
1914	99	...	100	101	102	102	105	109
1915	102	...	105	99	103	107	106	112
1916	125	...	124	118	113	113	121	123
1917	172	...	149	175	140	119	182	201
1918	192	...	176	204	175	131	203	243
1919	202	...	202	215	204	135	218	270
1920	225	...	201	211	236	159	212	230
1921	142	...	152	124	164	134	132	134
1922	141	...	149	132	145	124	127	133
1923	147	...	152	143	160	122	134	147
1924	143	...	152	143	165	118	133	150
1925	151	...	156	156	165	110	159	180
1926	146	...	155	146	170	105	155	183
1927	139	...	153	142	173	99	147	171
1928	141	...	155	151	169	96	154	163
1929	139	...	154	149	169	94	151	172
1930	126	...	146	128	154	90	128	142
1931	107	84	126	90	120	82	89	105
1932	95	58	108	68	92	70	63	77
1933	96	61	108	72	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	109	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	122	118	75	128	164
1938	115	87	123	97	117	74	103	145
1939	113	103	121	95	117	76	95	146
1940	114	117	122	100	116	77	99	148
1941	127	170	131	124	138	80	127	199
1942	144	227	154	159	173	89	160	266
1943	150	...	164	192	216	97	193	319
1943								
January	149	268	158	182	196	...	174	283
February	149	275	160	178	...	...	177	261
March	150	282	161	182	...	97	181	287
April	151	284	162	185	212	...	190	296
May	152	289	163	187	...	...	199	318
June	151	293	164	190	221	...	199	318
July	150	291	165	188	229	...	195	320
August	150	298	165	193	...	...	200	333
September	150	301	165	192	...	...	197	318
October	150	311	166	192	228	...	199	325
November	150	312	167	192	...	...	197	330
December	150	308	169	196	...	...	199	325
1944								
January	150	...	169	196	229	...	190	318
February	151	...	170	195	...	...	190	301
March	151	...	170	196	...	111	192	318
April	152	...	170	196	243	...	192	309

*SOURCE: Bureau of Business Research, The Ohio State University.

ANNOUNCEMENT OF SPECIAL DAYS

DAIRY DAY

August 11, 1944

Dairy Day will be held at the Ohio Experiment Station, Wooster, on Friday, August 11, in cooperation with the Ohio Dairymen's Association.

The morning program, starting at 9:30, will consist of demonstrations and tours showing the work of the dairy and cooperating departments of the Experiment Station. Mastitis, quick milking, artificial insemination, silo structures, grass silage, and barn curing of hay will be demonstrated and discussed. The morning program will culminate with a discussion of all phases of Bang's disease in cattle, by Dr. I. F. Huddleson of Michigan State College. Dr. Huddleson is recognized as one of the world's greatest authorities on Bang's disease, and this will be a rare opportunity for dairymen to discuss their problems with him.

Mr. B. O. Skinner, President of the Ohio Dairymen's Association, will preside over the afternoon meeting. Following a few words of welcome by Dr. Edmund Secrest, Director of the Experiment Station. Mr. H. E. Denlinger, a member of the Bang's Committee of the Ohio Dairymen's Association, will describe the Bang's eradication program in Ohio and will point out how dairymen can be helpful in eliminating this serious disease. After ample time for discussion, opportunity will be afforded for visiting the pasture farm where bluegrass is being compared with various alfalfa mixtures.

ORCHARD DAY

August 17, 1944

Orchard Day will be held at the Ohio Agricultural Experiment Station, Wooster, in cooperation with the State Horticultural Society as usual, on Thursday, August 17. Orchard tours, exhibit material, and a disease and insect clinic make up the morning program. The speaker for the afternoon will be a nationally known horticulturist.

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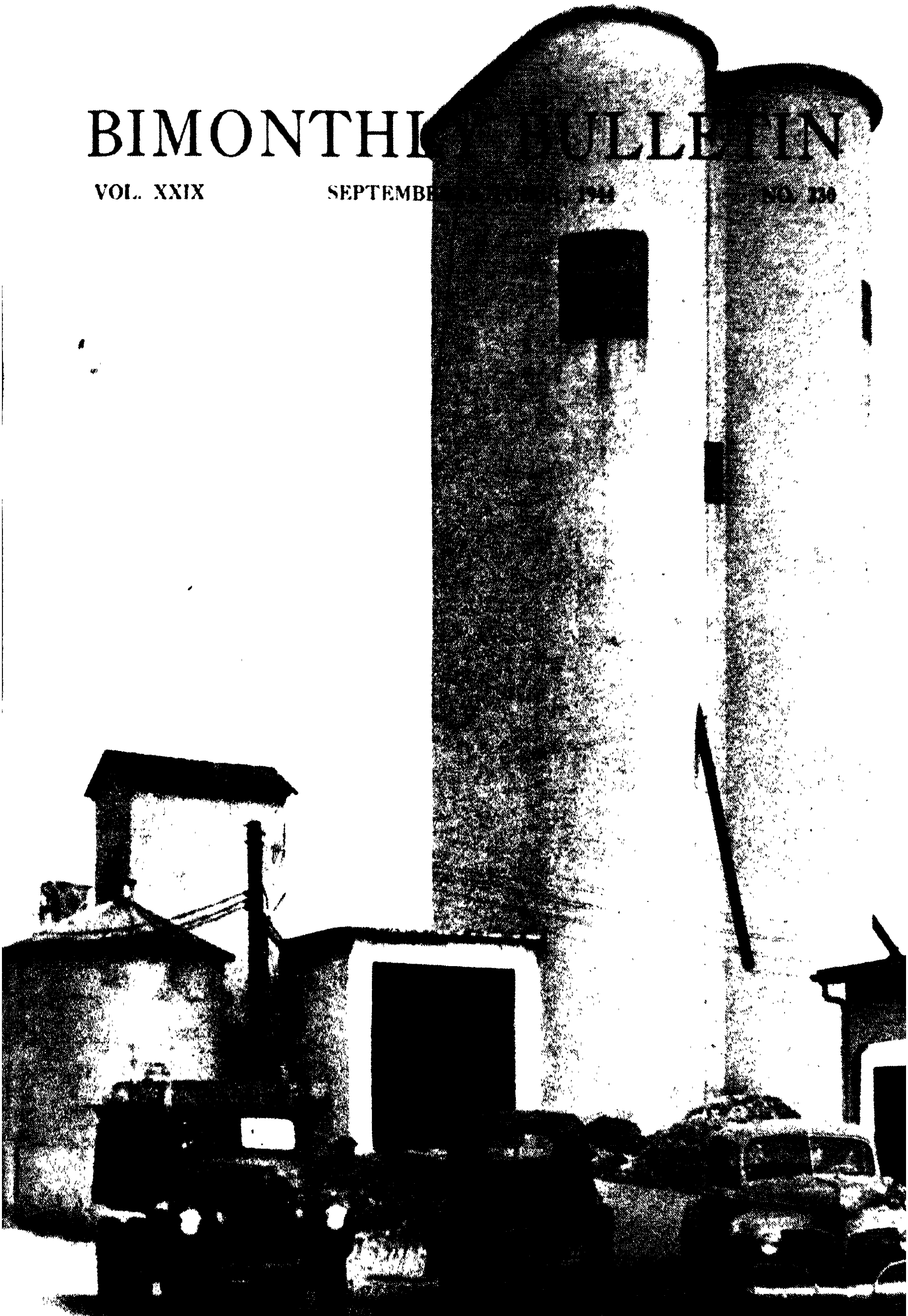

OHIO AGRICULTURAL EXPERIMENT STATION

WOOSTER, OHIO, U.S.A.

MEET YOUR AUTHORS

Donald Comin and C. W. Ellenwood, of the Horticulture Department, join with W. A. Junnila, of the Department of Agricultural Engineering, to produce an article pertaining to the effect of forced-air or blower type cooling equipment on the keeping of apples in storage. In connection with this they discuss the relation that relative humidity bears with apple shriveling.

Junnila

The moving of pullets from range to laying quarters involves new and exacting feed requirements. D. C. Kennard and V. D. Chamberlin, poultry specialists, give valuable information pertaining to what and how to feed pullet layers. This article should prove interesting to you poultry raisers who will be moving your pullets during September and October.

Chamberlin

Authors, already familiar to the readers of the Bimonthly Bulletin, who have contributed materiai for this issue are: Donald Comin, C. W. Ellenwood, and Wesley P. Judkins, of the Department of Horticulture; D. C. Kennard, poultry specialist; and J. I. Falconer, of the Department of Rural Economics and Rural Sociology. We have two guest authors from The Ohio State University appearing in this issue. They are: B. A. Wallace, of the Department of Rural Economics and Rural Sociology; and T. H. Parks, of the Entomology Department.

The front cover shows a view of the Grove City Farm Elevator, Grove City, Ohio. This photograph, taken by C. E. Wilson, Extension Photographer at The Ohio State University, was obtained through the cooperation of J. E. McClintock, Extension Editor at The Ohio State University.

CONTENTS

THE FARMER OWNED ELEVATORS OF OHIO

B. A. WALLACE AND J. I. FALCONER

The cover page presents a view of the main plant of the Grove City Farmers Exchange. This is one of the larger companies owned by Ohio farmers through which to sell grain and to buy farm supplies. In the state there are some 150 of these companies. Thirty of these operate two to five plants each, so that the total number of plants operated by the 150 companies is nearly 200.

These companies, especially those in western and northern Ohio, were set up primarily to handle grain. Grain, including soybeans, today constitutes nearly 60 per cent of their total volume. Together with the livestock, hay, and wool handled by a few, the farm products make up about five-eighths of the total volume. Today they all handle feed (averaging about ten per cent of the total volume) and nearly all handle coal, fertilizer, and twine. More than half of them sell seed, fence, and salt, and many handle shelf hardware, farm tools, farm machinery and repair parts, lumber, building materials, gas, oil, and spray materials. A few offer electrical appliances. Had feed, fence, and building materials been available in quantities desired by their trade, it is likely that farm supplies would have made up fully half of the volume.

From about 145 of these companies the Rural Economics Department gets yearly reports covering their financial condition and their operations for the year. For the year 1942-1943, these companies handled a volume of nearly $49,000,000 or $330,000 per company. To conduct this business the 35,000 to 40,000 farmers owning these companies controlled at the end of the 1942-1943 year plant facilities to a value in excess of $3,000,000 after depreciation, inventories valued at nearly the same amount, $2,200,000 of cash, and investments and other assets to a grand total in excess of $10,000,000. The farmers owned net over indebtedness 90 per cent of this total.

Any study of trends of this farmer elevator development must go back for certain general facts to a period for which detailed data are not available. Most of these companies were organized in the period 1910-1920, a period when farm incomes were rising rapidly. These companies started out undercapitalized and in debt for plants bought all too often at inflated prices. Besides all this they had to start with boards of directors and often managers who had had but limited, if any, experience in this type of business.

The price crash of 1920-1921 wiped out many of these companies and left others with a legacy of heavy debt. For the next 10 or more years, companies were occasionally falling by the wayside as a result of the conditions dating back to this early period. Most of the companies, however, had succeeded in the later 20's in paying off most or all of their indebtedness, in improving plants and equipment, and in further adapting themselves to community needs.

A few figures will picture better than words the progress these companies have been making since 1929. To avoid the element of chance in the occasional "good year" or "bad year" this table presents the average of the yearly averages per company.

TABLE 1.—The average of the yearly averages per company for 1938-1943 as compared with those of ten years earlier

	Average per year 1928-33	Average per year 1938-43
	Dollars	*Dollars*
Volume of business	132,977	227,926
Total income	14,328	25,298
Total expenses	12,308	18,318
Net savings	2,020	6,980

For the single year 1942-1943 these figures were: volume, $330,231; total income $33,647; total expenses, $21,792; net savings, $11,855. Data already indicate somewhat higher figures for 1943-44.

TABLE 2.—The trend in financial condition for every third year of the period under study

	Average surplus per company	Weighted average book value of $100 of stock
	Dollars	*Dollars*
1930-31	9,993	136.71
1933-34	8,574	132.42
1936-37	17,026	164.34
1939-40	18,098	165.06
1942-43	26,401	187.73

The types of assets held by these companies, shown in averages per company for 1942-43, are as follows: value of plant less depreciation, $21,700; inventory of grain and merchandise, $18,700; cash, $15,300; receivables, $11,200; with investments and minor assets to make the total assets $69,770. The net worth per company is $56,500, made up of stock above $30,000 and working capital reserves of $26,400.

The material examined thus far pictures an advance to a high degree of financial soundness. Along with this development, other changes have come. To the original grain handling with which these companies started, especially in western and northern Ohio, they have added grinding and mixing of feeds, the handling of added types of farm supplies, the cleaning of grain and seed, hauling and delivery service, the provision of larger and better scales, separate driveways for grinding, farm machinery repairs, and other services as needed.

Another very noticeable trend is the increasing tendency to return the savings made, not alone in a return on the stock, but to patrons as patrons. The first ten records available on this point in the 1943-1944 data show that of $225,000 in savings, $129,000 was refunded in patronage dividends.

THE WHEAT INSECT SITUATION AS DETERMINED BY THE SURVEY OF 1944

T. H. PARKS

Thirty-three Ohio counties were visited by entomologists just before the 1944 wheat harvest to inspect the wheat for Hessian fly and other wheat insects. Ten fields were selected at random in each county and the percentage of straws that had been fed upon by the Hessian fly was determined in each field. The average for these fields then constituted the average existing county infestation. Armed with these data, entomologists compare the degree of infestation with that present the previous year, and are able to predict with some degree of accuracy impending wheat insect outbreaks and to map-out their probable distribution.

HESSIAN FLY

The 1943 and 1944 surveys both revealed a very favorable situation with respect to Hessian fly. The fly population during the season of 1944 was at the lowest level since the annual wheat insect survey was inaugurated 27

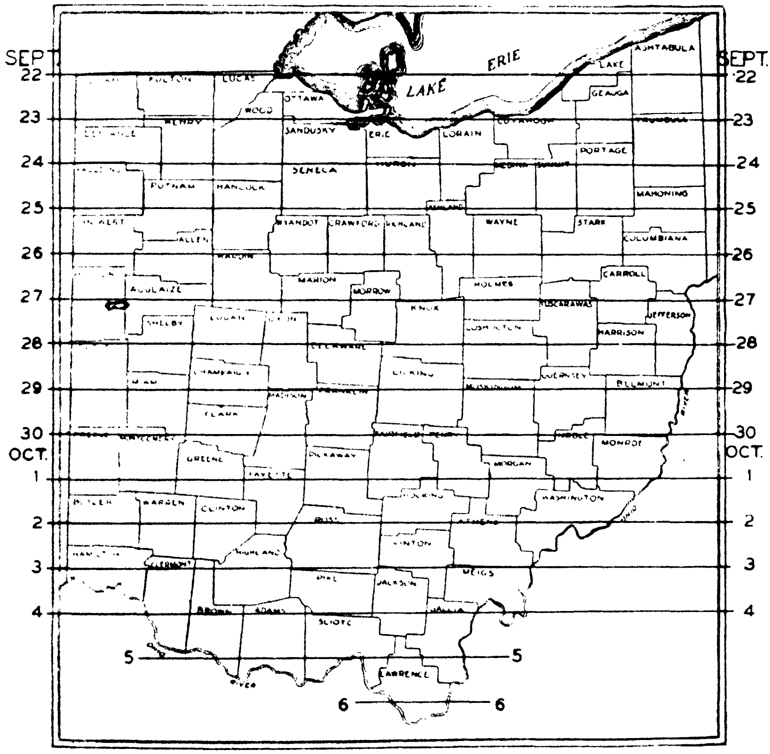

Fig. 1.—Hessian fly safe-sowing dates

years ago. During the first half of this period the fly-free or safe-sowing dates were worked out for all parts of the State. Most Ohio farmers now place confidence in these dates and wait for them to sow wheat. This has contributed to the favorable situation we have enjoyed recently with respect to Hessian fly. Previous to 1920 much wheat was sowed too early with periodical heavy losses resulting from Hessian fly.

The infestation now present in wheat stubble is very light. In only three counties surveyed in 1944 has the insect increased over that present 1 year ago. The highest infestation at present is in Seneca County which has 12 per cent of the straws infested. Several counties have only a trace. The state average of 3 per cent constitutes a very satisfactory situation.

TABLE 1.—The Hessian fly infestation figures for Ohio during the past 27 years, and for each county surveyed in 1944

Year	Infestation by years	County	Infestation in 1944
	Per cent		*Per cent*
1918	1.0	Allen	2.0
1919	14.4	Ashland	9.0
1920	44.0	Auglaize	2.0
1921	17.1	Butler	1.0
1922	11.0	Champaign	Trace
1923	4.3	Columbiana	2.0
1924	10.3	Crawford	10.0
1925	7.5	Darke	Trace
1926	9.1	Defiance	2.0
1927	20.8	Fulton	1.0
1928	13.6	Greene	1.0
1929	4.6	Hamilton	Trace
1930	6.8	Hancock	6.0
1931	12.2	Hardin	8.0
1932	35.5	Henry	Trace
1933	8.1	Highland	1.0
1934	15.5	Holmes	4.0
1935	29.3	Licking	2.0
1936	12.4	Madison	Trace
1937	4.3	Medina	5.0
1938	10.0	Mercer	2.0
1939	20.5	Miami	1.0
1940	4.0	Paulding	1.0
1941	12.1	Pickaway	1.0
1942	25.7	Preble	4.0
1943	4.3	Putnam	1.0
1944	3.0	Seneca	12.0
		Stark	2.0
		Union	3.0
		Van Wert	4.0
		Warren	2.0
		Wayne	3.0
		Williams	1.0
		State average	3.0

RYE AND BARLEY NOT OFTEN DAMAGED

Hessian fly rarely infests rye which crop can be safely sowed early in any year. Winter barley is usually not seriously damaged. This year there is so little fly infestation present that we believe winter barley may be sowed early with safety. There seems to be an advantage in early sowing of fall or winter barley as it is thought by agronomists to promote higher yields. In years when fly is serious, early sowing of winter barley should be discouraged. Oats is not infested by the Hessian fly.

OTHER WHEAT INSECTS

The wheat midge, sometimes called red weevil, was more abundant in 1944 than for several seasons. This is the tiny orange-colored maggot that is found in the threshed grain as it comes from the combine or thresher. It is the larva of a small midge-like fly that lays its eggs in the developing heads while the kernel is partially developed and soft. The eggs hatch into small orange maggots that feed on the side of the kernel which they may deform or convert into a light chaffy grain that blows out with the straw. The wheat midge has long been present in Ohio, but rarely becomes serious. Control measures have not been necessary and do not fit into our crop rotation. This insect never damages wheat in the bin and cannot survive in stored grain.

Wheat jointworm, the black wheat stem sawfly, and chinch bugs were very scarce this year. Nor were there any outbreaks of army worms which sometimes cut off the heads from the ripening straws. Wheat jointworm has been held in check by parasites and has not bothered seriously for many years. The black wheat stem sawfly, which was very injurious in a number of northeastern counties in 1934, 1935, and 1936, has subsided to the point where damage could scarcely be measured even in counties where the losses were severe 10 years ago.

CONTROL OF WHEAT INSECTS

Some wheat insects, like the wheat midge, jointworm, and black wheat stem sawfly can be controlled only by plowing under of stubble to bury the overwintering stage. This practice does not fit into Ohio crop rotations. Fortunately, these insects are not usually serious enough to require control. The Hessian fly is best controlled by community-wide observance of the safe-sowing dates. These dates, which are here given, are now permanent and do not change from year to year. They are not always "fly-free", but dependable enough to deprive the insect of wheat plants on which to lay eggs during the emergence of the main brood. This is all that is required and is accomplished without extra expense or effort. Seeding should, if possible, be completed within 10 days after these dates to insure maximum yields. There is no advantage from sowing wheat earlier than these dates on well-prepared and well-fertilized soil.

It never will be possible to totally eradicate fly as a pest because of the presence of volunteer wheat in old stubble fields. The combine harvester and thresher through shattering adds to the volunteer wheat problem, particularly if a rainy season follows immediately after harvest. It is apparent, however, that the volunteer wheat in stubble fields is less of a hazard than that present in the seedbed of a plowed stubble field to be placed back to wheat. This should be completely destroyed before sowing the wheat.

FEEDING THE NEW CROP OF PULLET LAYERS[1]

D. C. KENNARD AND V. D. CHAMBERLIN

Poultry raisers are now concerned with what and how to feed the new crop of pullet layers. More pullets are ready to be transferred from range to laying quarters during September and October than during all other months combined. This moving of pullets involves new and exacting feed requirements.

Inasmuch as pullets on good pasturage generally have had a comparatively simple mash and whole grain (in some instances, only whole grain), the transfer of pullets from pasturage to laying quarters indoors or to where good pasturage is not available means that the mash must contain the nutritive factors previously provided by green feed and sunshine. Moreover, the ration must meet the additional requirements for egg production. Since pullets continue to grow a few months after they start to lay, their diet during this period will need to be adequate for growth as well as egg production.

WHAT AND HOW TO FEED PULLET LAYERS

During the wartime scarcity feed situation the question of what and how to feed the new crop of pullets may become a critical problem in many instances.

THE MASH

In many respects the mash considerations are of the greatest importance, since only by means of the mash can certain essential protein, mineral, and vitamin supplements be provided. Hence, there are certain fixed mash requirements which limit or exclude substitutions in case of scarcity or unavailability of these special ingredients. For example, a certain amount of meat, fish, or milk products or their equivalents are necessary to supplement plant feed products if best results are to be secured. In addition to the animal feed products, a vitamin D supplement is also essential during the fall and winter months.

The scarcity and higher price of wheat bran and middlings often give rise to the question of substituting coarsely ground wheat for the wheat by-products. Wheat bran and middlings, because of their concentration of the most valued nutrients of wheat, are preferable to ground wheat in the mash for layers. This fact has been made evident in the experimental results given in table 1.

[1]For suggestions relative to the transferring of pullets from range to laying quarters and their management after housing, refer to the Ohio Agr. Exp. Sta. Bimo. Bull. Sept.-Oct., 1943.

TABLE 1.—Egg production and feed consumption as affected by the ration and method of feeding Rhode Island Red pullets

September 15, 1942, to August 31, 1943—50 weeks

Ration and method of feeding	Eggs per bird	Total feed per bird	Feed per dozen eggs	Feed consumption					Per cent protein of total feed intake
				Corn	Oats	Wheat	Total whole grain	Mash	
		Pounds	*Pounds*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
*Whole oats—mash mixture with bran and middlings...	145	115	9.53	......	20	....	20	80	16.7
Whole oats—mash mixture with ground wheat.....	129	110	10.21	......	20	....	20	80	16.7
*24% protein mash. Free choice of corn and oats	122	121	12 03	45	31	....	76	24	13.5
24% protein mash. Free choice of corn, oats, and wheat...	103	116	13.56	30	21	26	77	23	13 7

*Controls.

If, however, owing to the unavailability of wheat bran and/or middlings, it becomes necessary to substitute ground wheat, it is very necessary that the wheat be coarsely ground (merely cracked) for best results. Coarsely ground wheat will more nearly serve as a substitute for wheat middlings than for bran. The bran should be retained in the mash for layers when possible, even when it becomes necessary to substitute coarsely ground wheat for the middlings.

WHOLE GRAIN

Unlike the exacting mash requirements, there is a wide choice of whole grains for feeding layers. In fact, any one or two of the whole grains can be successfully used. While corn and oats or barley are generally preferable when available, however, either corn, wheat, oats, or barley (whichever may be available) can be used to advantage.

From the point of feeding value, there is no great difference in the grains except that yellow corn contains vitamin A, which can, however, be provided from other sources. The greatest liability in changing from one grain or combination to another with which the birds are unfamiliar is that during the change-over period the birds may reduce their grain consumption while they are becoming accustomed to the change. This may interfere with the rate of growth or egg production. If, however, the change can be anticipated so that

the birds can be gradually familiarized with the new grain during 1 to 3 weeks while the old grain is yet available, the change can be made without complications.

During the first few days or a week, the new grain (whole and/or ground) can be used half and half with the old, after which the mixture can be one-fourth old and three-fourths new. Moreover, when breaking the birds in on a new grain, it is well to scatter the new whole grain over the top of the mash in the mash feeders two or three times a day in about the amount that will be consumed between times. This is a good procedure for getting the birds accustomed to any other grain that may have to be used later. Then, if or when the change becomes necessary, the birds will already be prepared for it.

Chickens are extremely cautious about eating grain with which they are unfamiliar. This is why interference in growth or egg production may follow a sudden change to another grain, rather than to a difference in the feeding value of the grain. To familiarize chickens completely with a strange grain may require from 1 to 3 weeks, depending upon the procedure used. When there is an uncertainty of grain supplies, chickens should be kept familiar with all of the different grains that may have to be used later.

Yellow corn has the advantage over other grains in that it contributes a considerable amount of the highly essential vitamin A to the ration. Consequently, when yellow corn is replaced by other grains, it is necessary to make sure that the ration without yellow corn contains ample vitamin A from other sources, such as green feed, high-quality legume hay or meal (preferably dehydrated), or vitamin A and D feeding oil. The feeding oils generally provide vitamin A as well as vitamin D.

Oats of good quality and weight are a valuable grain for feeding layers. Oats provide nutritive factors which tend to improve the plumage condition and aid in the prevention or control of feather picking and cannibalism of layers confined indoors. When oats of good weight and quality are available at a reasonable price, they should constitute 20 to 30 per cent of the total feed intake by layers. It is generally preferable to feed whole rather than ground oats to layers. Whole oats may be fed by the free-choice method, by hand, or as a whole oats-mash mixture. Light-weight oats are ill-suited for free-choice feeding because of the birds' refusal and wastage of the light kernels or empty hulls which have considerable feeding value. When necessary to feed lightweight oats, it is well to mix the oats with the mash and feed as a whole oats-mash mixture. By this procedure, there is little or no wastage due to refusal of the birds to eat the light oat kernels or empty hulls.

Wheat promises to be more available for poultry feeding as a result of this year's abundant crop. Consequently, poultrymen now have a special interest in the feeding of wheat for egg production. Chickens usually prefer wheat to any other grain. Owing to their preference for wheat and the liability of their failure to eat sufficient mash, it is not considered advisable to feed whole wheat by the free-choice method. A preferable method is to feed the wheat in the evening in one-half the amount of total whole corn and oats being consumed.

If wheat is the only whole grain being fed, it may be fed in the evening on top of the mash in about the amount that will be consumed at that time.

To secure information as to the effect of the free-choice feeding of whole wheat in connection with the free-choice feeding of whole corn and oats and the effect of substituting coarsely ground wheat for bran and middlings in the mash for layers, an experiment was conducted with 4 groups each of 45 Rhode Island Red pullet layers by the Ohio Agricultural Experiment Station at Wooster.

The whole oats-mash, complete feed mixture with bran and middlings used as the control ration in this experiment has proved to be one of the best rations and methods of feeding in five other experiments. The 24 per cent protein mash has been frequently used in connection with the free-choice feeding of whole corn and oats. The results from these two control rations in comparison with the use of coarsely ground wheat in place of bran and middlings and the free choice of whole wheat in addition to the free choice of whole corn and oats are given in table 1.

While the egg production was low in all the groups, it was still lower when the 10 per cent bran and 15 per cent middlings were substituted by 25 per cent coarsely ground wheat, or when the birds had the free choice of whole wheat in addition to the free choice of whole corn and oats.

Both groups of Rhode Island Red pullets which had the free choice of whole grain in this experiment failed to consume as much mash as needed for egg production. It is interesting to note that while the proportion of total whole grain consumed by the group which received the free choice of whole wheat was only 1 per cent more than the group which received the free choice of whole corn and oats, the egg production of the group which received the free choice of whole wheat, corn, and oats was considerably less. While the results of a single experiment should not be regarded as conclusive, nevertheless, the results of this experiment are in line with generally accepted expectations with regard to the relative nutritive value of ground wheat as a substitute for bran and middlings, and the questionable practice of the free-choice feeding of whole wheat to layers.

CALCIUM FOR EGG SHELLS

A special feeding requirement, as important as any part of the ration for layers, for egg production is to provide a calcium supplement from which strong egg shells can be made. In a recent experiment by this Station, the layers without a calcium supplement laid only half as many eggs as did similar layers in an adjoining pen which received ample calcium for egg shell formation. Moreover, many of the eggs from the birds denied the calcium supplement were unmarketable because of thin and weak shells.

The needed calcium for layers can be provided by the free-choice feeding of oyster shell or other shell equally effective or by feeding high-calcium (90 per cent or more calcium carbonate) P. F. G. (poultry feeding grade) limestone grit. Dolomitic limestone (limestone high in magnesia) is ill-suited for feeding layers. In recent experiments at this Station, the egg production of the layers which received dolomitic limestone grit was greatly reduced and in

addition to this the thin or weak shells on many of the eggs rendered them unmarketable. Poultrymen should, therefore, make sure that their pullet layers always have free access to shell material or P. F. G. (90 per cent or more calcium carbonate) limestone grit.

SUMMARY

The feeding requirements are very exacting for pullets moved from good pasturage to laying quarters indoors or where green feed is not available. The ration must then provide the many nutritive factors previously provided by pasturage, including sunshine (vitamin D) if the pullets are confined indoors.

Pullets continue to grow a few months after they start to lay. Consequently, ready-to-lay pullets require a ration for growth as well as the additional requirements for egg production.

The mash is of first importance in connection with the feeding of pullet layers confined indoors without green feed, since only by means of the mash can certain essential protein, mineral, and vitamin supplements be provided.

In the experiment conducted with Rhode Island Red pullet layers by this Station, coarsely ground wheat was a poor substitute for bran and middlings in the mash for egg production. The pullets, which received the free choice of whole wheat in addition to the free choice of whole corn and oats, laid considerably less eggs than did the pullets which received the free choice of whole corn and oats only. Both groups of pullets which received the free choice of whole grain failed to consume as much mash as needed for egg production.

Whole wheat is a valuable grain for feeding pullet layers. Owing to their preference for wheat over other grains and the mash, it is not considered advisable to feed whole wheat by the free-choice method. A preferable method is to feed the whole wheat in the evening in one-half the amount of the total corn and oats being consumed. If wheat is the only whole grain being fed, it may be fed in the evening on top of the mash in about the amount that will be consumed at that time.

A suitable calcium supplement from which strong egg shells can be made is as necessary as any part of the ration for layers. To provide ample calcium, the layers must have free access at all times to oyster shell or other suitable shell material or high-calcium (90 per cent or more calcium carbonate) P. F. G. (poultry feeding grade) limestone grit. Dolomitic magnesia limestone grit not only reduces egg production but causes further loss of eggs because of thin or weak shells.

CURRANT AND GOOSEBERRY CULTURE IN OHIO

WESLEY P. JUDKINS

Although currants and gooseberries are produced in relatively small amounts on a commercial scale in Ohio, they are important sources of fruit in backyard gardens. According to the U. S. Sixteenth Census report there were 106 acres of currants in Ohio in 1940 which produced 110,400 quarts of berries. Gooseberries occupied about 15 acres and produced about 13,000 quarts of fruit in the same year.

Well-cared for plantings will usually produce good crops for 8 to 10 years, and may give satisfactory yields for as long as 20 years. Vigorous, healthy plants will produce 4 to 6 quarts of fruit each year. Commercial fruit growers in favorable locations might increase their profits by planting currants to diversify their production program.

VARIETIES

Wilder and Red Lake are probably the best red currants for Ohio. The Red Lake ripens slightly later than Wilder and produces larger clusters and berries. Both varieties are vigorous, hardy, and productive.

Downing is the standard green-colored gooseberry in Ohio. Poorman is a high quality red gooseberry, and is preferred by many growers. Fredonia is a good quality red variety ripening after Poorman. All of the above gooseberries are vigorous, hardy, and productive.

The commonly planted varieties of currants and gooseberries are self-fertile where insects are present to facilitate pollen transfer and, therefore, no provision need be made for cross-pollination.

CLIMATE, SITE, AND SOIL

Currants and gooseberries are very hardy to cold but do not grow well where summer temperatures are high. A northern slope which is not subjected to hot, drying winds is usually preferred.

Well-drained fertile silt or clay loam soils are ideal for both currants and gooseberries. These plants are intolerant of lack of moisture which is more common on lighter soil types.

PROPAGATION

It is usually advisable for the grower to purchase strong 1- or 2-year-old plants from a nursery rather than attempting to produce plants at home. For those who already have good varieties which they desire to propagate the procedure is, however, relatively simple.

Currants are propagated by cuttings of 1-year-old wood which may be taken any time during the dormant season. The cuttings, which are about 8 inches long, should be tied in small bundles and placed basal end up in a box of moist sand in a cool place. In early spring the cuttings should be set in the garden or nursery about 6 inches deep and 6 inches apart in rows 3 or more feet apart.

If only a few plants of gooseberries are needed they may be secured by bending down a few branches in spring or fall and partly covering them with soil. If a considerable number of plants are needed they may be secured by mound layering. This procedure consists of cutting back all branches in early spring to leave stubs about 3 to 4 inches long. In July the vigorous shoots which develop are mounded up about half their length with earth. The rooted shoots may be removed in the fall or spring.

PLANTING

Currants and gooseberries start growth in early spring and, therefore, should be set out as soon as the ground can be prepared. Plants should be set in the field as soon as they are received, or heeled-in in a protected place. Fall planting is desirable, but it is frequently difficult to get plants from nurseries at the right stage of maturity at this season of the year.

The planting distance for currants and gooseberries varies with the vigor of the variety and the type of equipment which is to be used in cultural and spraying operations. Plants are usually spaced 4 to 5 feet apart in rows 5 to 8 feet apart.

Only vigorous 1- or 2-year-old plants should be set out. Damaged roots should be removed and the branches cut back to about 5 inches long. Set the plant firmly in well-prepared soil with the lowest branches just below the surface of the ground to encourage the development of a bush rather than a tree-like type of plant. In loose soils a sufficiently large hole may be made by inserting a shovel deeply into the earth and moving it back and forth to make a V-shaped opening. In heavier soils a hole should be dug to receive the plant.

CULTURE

The most common procedure is to cultivate currants and gooseberries during the early summer until about the time the fruit is picked and then allow weeds to develop, or sow a cover crop to protect the soil from erosion during the remainder of the year. Tillage operations should be shallow to avoid excessive injury to the roots which grow relatively near the surface of the soil.

The use of straw or other mulching material around the plants is an excellent practice (1). The mulch suppresses weeds, conserves moisture, and keeps the soil cool. Extra nitrogen fertilizer will usually be necessary when the mulch is first applied. The mulch may harbor mice which girdle the plants, but this problem usually can be controlled by the use of poisoned bait.

No winter protection is needed for currants or gooseberries, except possibly the tying together of the canes where damage from snow or ice breakage is frequent.

FERTILIZATION

Currant and gooseberry plants grow best in a fertile soil and usually respond to manure when used at the rate of 10 to 20 tons per acre. If manure is not available a nitrogen fertilizer, such as nitrate of soda, or ammonium sulfate may be used at the rate of 200 pounds per acre, or about one-fourth pound per plant. Ammonium nitrate is also satisfactory if used at the rate of 150 pounds per acre. The manure, or fertilizer, should be applied in early spring.

Shoemaker, J. S. 1935. Effect of fertilizer and mulch on yield of red currants. . Exp. Sta. Bimo. Bull. 20 (173): 82-88.

Experiments (1, 2) with commercial fertilizers have shown that there is usually no advantage to be gained from using phosphorus or potassium except where potassium deficiency has been encountered.

The use of cover crops during late summer and fall to help maintain organic matter and reduce soil erosion is a desirable practice.

PRUNING AND TRAINING

Currants and gooseberries produce the most fruit on spurs located on 2- and 3-year-old wood. It is essential that mature bushes be pruned each year during the dormant season, leaving about 8 canes per plant, including about equal numbers of 1-, 2-, and 3-year-old wood. All canes over 3 years old should be removed.

In the drooping type bushes the low branches near the ground should be removed, leaving the more erect growing stems. In erect growing types an effort should be made to thin out the canes to give a more spreading bush. No heading-back of canes is necessary in most currant and gooseberry varieties.

DISEASES AND INSECTS

Most backyard plantings of currants and gooseberries will produce fairly good crops of fruit with little or no attention to insect and disease control. If problems do arise the grower should consult the Ohio Agricultural Experiment Station Bulletin No. 599, "Spraying Program and Pest Control for Fruit Crops," which gives directions for controlling pests on all types of fruit plants.

HARVESTING

Currants and gooseberries may be left on the bushes for 4 weeks, or possibly longer, after they first become ripe. There is little danger that the fruit will become too soft, although if the foliage is sparse the fruit may sunscald.

Currants should be picked carefully in clusters when all berries in the cluster are red. The fruit is usually picked into quart baskets. Gooseberries may be stripped from the bush with gloved hands if they are to be used immediately for jelly, jam, or preserves. If the fruit is to be held for any length of time it should be harvested more carefully.

As soon as the fruit is picked it should be placed in a cool, shady place.

USES

Currants and gooseberries are commonly used for jelly and jam, and to a lesser extent for pies, tarts, and preserves. These fruits have not received the attention their good qualities deserve, because they are seldom offered on the market in a fully ripe, high quality condition. Ripe gooseberries are an excellent dessert fruit, and not appreciated fully in this country as they are in Europe.

2. Anderson, L. C. 1934. Four years of commercial fertilizers on currants in the Hudson River Valley. N. Y. (Geneva) Agr. Exp. Sta. Bull. 641.

THE LOSS OF MOISTURE AND SHRIVELING IN APPLES IN STORAGE

DONALD COMIN, WILLIAM JUNNILA, AND C. W. ELLENWOOD

The two greatest difficulties in holding apples in storage are: (1) to retard ripening or softening of the fruit and (2) to prevent loss in weight and subsequent shriveling of the fruit. It has been well established that by lowering the storage air temperature toward the freezing point the fruit ripens and softens at a slower rate, due primarily to a lessening of the respiration rate.

In order to maintain a desirable low storage temperature, cooling of the air by refrigeration is required, especially during the early fall months. Refrigeration, besides cooling the air, also lowers the relative humidity of the air due to the constant condensation of moisture in the air onto the cooling coils or evaporator. The amount of moisture removed on the cooling coils and that portion re-evaporated into the air with varying evaporator temperatures is fully discussed in an earlier publication (1).

Many of the newer installations of refrigeration in apple storages are of the forced-air or blower types wherein a fan is employed to circulate the air over the cooling coils and apples in the storage. The older type of refrigeration employed cooling coils on the walls or suspended from the ceiling over which the storage air circulated only by gravity movement.

The question immediately arose as to whether the faster moving air in the blower equipped storage would not increase the rate of water loss from the apples and thus hasten the appearance of a shriveled condition of the fruit. The data presented in bulletin 632 (1), where as many as 45,000 fruits were examined in 1 year, show that there was less weight loss, less shrivel, and that the fruits softened slower in the forced-air cooled storage than in the refrigerated storage with gravity air movement where the relative humidity was also lower.

To further determine the effect of air movement and relative humidity on the keeping of apples, some of the experiments were repeated and new experiments carried through to completion which gave evidence that if the relative humidity of storage air is maintained at close to 88 to 90 per cent, moving air causes little more water loss and shrivel of apples than still air.

To determine the air velocities encountered in a blower or forced-air equipped storage a traverse was made on top of the pile of crates and in other locations in the storage. A traverse at the face of the discharge grille showed a mean air velocity in feet per minute (using a velometer) of 465 at the top, 449 in the middle, and 450 at the bottom of the grille. The detailed traverse showed a good uniformity in the air velocity from point to point over the face of the grille.

In moving 5 feet from the grille and on top of the tier of crates there was a considerable drop in air velocity due to the widening out of the air stream. In table 1 are given the air velocities as recorded at 1-foot intervals in two directions.

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1. Comin, Donald. 1942. Refrigerated farm apple storages. Ohio Agr. Exp. Sta. Bull. 632.

TABLE 1.—Air velocity traverse over top of apples in crates in line with the discharge grille

West to east away from grille, 1-foot intervals	South to north in front of grille, 1-foot intervals. Number 3 in line with center of grille face and 5 feet away				
	1	2	3	4	5
	Ft. per min.	*Ft. per min.*	*Ft. per min.*	*Ft. per min.*	*Ft. per min.*
1	190	190	100	0	5
2	180	165	75	10	0
3	170	120	25	5	0
4	120	50	20	5	0
5	100	50	12	2	0
6	100	50	25	5	0
7	50	25	12	2	0
12	20	10	10	8	0

The data in table 1 reveal that the air comes out at an angle from this particular grille. This may be due both to the construction of the supply duct and grille face and the fact that the storage wall was close to one side. The significant point is that the velocity reduces as rapidly as the distance from the face of the grille increases.

An air velocity traverse of the room when empty showed the velocities to be of the order of 0 to 20 feet per minute. The velocity was greatest near the grille outlets, that is at the front of the room, and next greatest at the rear of the room where the air was deflected by the wall.

Air velocity measurements made in aisleways and between crates substantiated the previous findings that air velocity over the fruit is negligible except near the grille and at the back wall. Even in the aisleways the velocity was moderate. Thus, the majority of the fruit in crates in forced-air cooled storages is subject to only slow air movement which could not appreciably increase the transpiration of moisture from the fruit beyond that occurring in storage rooms with gravity air movement only.

In order to determine further the effect of moving air on transpiration of moisture from apples, 12 crates of Stayman Winesap apples were placed in front of a tunnel through which air was forced by means of a blower type fan. The crates were placed 6 inches from each other in 3 rows and air velocity measurements showed from 700 to 1000 feet per minute between the crates in the first row, from 400 to 500 feet per minute between crates in the second row, and from 200 to 300 feet per minute next to the crates in the last row farthest from the tunnel face. Weighings of the fruit each day or two showed only slight changes and no difference could be detected between the rows of crates. The tests were carried on at two relative humidities of 65 and 90 per cent, and each test was repeated with a new lot of fruit.

At the same time similar lots of fruit standing in still air were being weighed. The temperature was maintained at 40° F. and by means of a pneumatic water spray nozzle the humidity was controlled at the two desired levels.

In table 2 are given the results of these tests.

TABLE 2.—Loss in weight of apples in crates in moving and still air of varying relative humidity

Test number	Relative humidity and vapor pressure deficit of the air		
	65 per cent—2.21 mm. Hg		90 per cent—0.63 mm. Hg
	Still air	Moving air*	Moving air*
1.	1.73	4.35	2.03
2.	1.90	4.84	2.26

*Mean velocity, 900 feet per minute.

It may be seen from the data in the above table that there was only slightly more moisture lost from the fruits in moving air at 90 per cent relative humidity than in still air at 65 per cent humidity. However, when the relative humidity of the moving air was lowered from 90 per cent to 65 per cent the rate of transpiration more than doubled. It should be noted that the air velocity was far higher than is normally found in storages and thus accentuated the transpiration rate.

These data corroborate those of Pieniazek (2) who has shown by similar experiments that the effect of air movement on the rate of transpiration of apple fruits is negligible, amounting to about 5 per cent at most, provided that temperature and humidity are uniform throughout the storage chambers. He also pointed out that ventilation or any other sort of air circulation in commercial storages does not appreciably increase the shriveling of apples if a sufficiently high relative humidity is maintained throughout the room. If, however, the humidity is low, fruits in rooms with no circulation show less shriveling. This is due to the fact that humidity in the stacks of boxes increases due to transpiration of the fruit and hence diminishes the total water loss.

In order to determine the transpiration or loss of moisture from fruits as related to time in storage, as well as to condition of the crate holding the fruit and the effect of the concrete floor, 10 crates of Stayman Winesap apples were selected as samples and the crates in one lot were coated with paraffin on the inside and another lot was saturated with water before placing in storage. Some of the crates were placed on several layers of Pliofilm (moisture-vapor proof material) to eliminate any drying effect of the concrete floor.

In table 3 are presented data to show the effect of time on moisture (weight) loss or gain of the crates held in still air at 40° F. and 65 to 70 per cent relative humidity, and at 90 per cent humidity.

These data indicate that crates in storage come to moisture equilibrium with the air rapidly, either absorbing or giving off moisture, depending on the moisture already in the crate and relative humidity of the storage air. One

2. Pieniazek, S. A. 1942. External factors affecting water loss from apples in cold storage. Jour. of the Amer. Soc. of Refrigeration Engineers. 44: 171-173.

TABLE 3.—Change in weight of treated and untreated apple crates in storage
November 1943 to March 1944

Crate treatment	Weight in pounds per crate only, average of 10 crates		
	Initial	2 months in storage	4 months* in storage
	Pounds	*Pounds*	*Pounds*
Paraffin coated	8.7	8.7	9.1
Wetted	9.2	8.7	9.1
Crates on Pliofilm on floor: Wet crates	8.9	8.4	8.8
Crates on Pliofilm on floor: Dry crates	8.4	8.4	8.9
Control—dry crates	8.5	8.5	9.0

*The relative humidity of the storage room was raised artificially to 90 per cent during the last month.

bushel slat crates will absorb approximately one-half pound of water either from rain, if the crates are exposed to the weather, or from the vapor of the storage air. This fact has a bearing on the ease of maintaining a high relative humidity of the storage air, especially at the beginning of the storage period. If each crate in a 10,000 bushel storage were to absorb one-half pound of water at the beginning of storage, nearly 600 gallons of water would be absorbed from the air. Pieniazek (3) found that the dry field box used in New England absorbed over a pound of moisture and suggested that all wooden containers be wet down before going into storage. In this experiment carried on at the Station paraffin was applied to the inside of the crates with the idea that the apples may possibly give up moisture to the crate slats with which they come in direct contact. Unfortunately no thin-skinned apples such as Grimes Golden or Golden Delicious were available for this test, and the Stayman Winesap did not show shriveling to an extent where definite conclusions could be drawn.

In table 4 are given the moisture losses (losses in weight) of apples placed in crates with different treatments and in different positions in storage. It was thought by this means that the effect of the crate and the concrete floor on the moisture loss from the fruit could be determined.

TABLE 4.—Loss in weight of apples in treated and untreated crates in storage

Loss of weight in per cent of initial weight, average of duplicates, November 1943 to March 1944

Position of crates	Crate treatment		
	Dry crates	Wet crates	Paraffined crates
	Per cent	*Per cent*	*Per cent*
On the floor	10.1	11.6	10.9
On Pliofilm on the floor	9.9	11.0	....
In second tier above floor	9.2	8.8	8.7
In third tier above floor	8.4	10.6	8.6
In fourth tier above floor	8.9	11.7	10.4
In fifth tier above floor	9.7	11.7	9.8

3. Pieniazek, S. A. 1942. Absorption of moisture by apple boxes. Ice and Refrigeration Jour. July.

The data in the preceding table were corrected for changes in the weight of the crates. For some unexplained reason the fruit in the wetted crates lost slightly more moisture than those in the dry crates and those in the dry paraffined crates. The single exception was in the case of the apples in the second tier above the floor which lost slightly less moisture. It may also be noted that the fruits in the second tier above the floor lost less moisture in each case than those comparable crates on the concrete floor. The Pliofilm seemed to have an insignificant effect on reducing moisture loss, although in each case the fruit on Pliofilm lost slightly less moisture than those fruits directly on the floor.

More detailed experiments will be necessary to prove conclusively the effect, if any, of the crate and the concrete floor on the loss of moisture from apple fruits.

The fruits in these experiments were weighed each month throughout the storage period and the data in table 5 show that at 40° F. and 65 to 70 per cent relative humidity the moisture loss was not constant but that approximately two-thirds of the total transpiration took place during the first 2 months in storage.

TABLE 5.—Per cent of total loss in weight of apples in treated and untreated crates by months, average of 10 crates. November 1943 to March 1944

Crate treatment		November to December	December to January	January to February	February to March
		Per cent	*Per cent*	*Per cent*	*Per cent*
Paraffined		36.9	31.3	22.0	9.8
Wetted		42.5	27.9	20.3	9.3
Crates on Pliofilm on floor	Wet	42.3	34.4	10.6	12.7
	Dry	34.5	31.5	21.3	12.7
Dry crates		34.4	32.3	21.3	12.0

Smith (4) in England and Pieniazek (5) in this country have shown that the transpiration value for apples per millimeter of mercury of vapor pressure deficit is constant and independent of humidities and temperatures employed only when the transpiration rate is measured for a short period of time. At low humidities and high temperatures the rate of transpiration decreases with time, mainly because of the drying out of the apple skin.

SUMMARY AND CONCLUSIONS

In order to determine the effect of forced-air or blower type cooling equipment on the keeping of apples in storage, various types of experiments have been carried on in the Station storages artificially refrigerated with gravity air movement and with fans to increase air circulation.

4. Smith, A. J. M. Evaporation from foodstuffs. Great Britian Dept. Sci. Ind. Res. Food Inv. Bd. Rpt. 1932. 117, 138, 1933.

5. Loc. cit.

The data secured over a period of years show that there is actually less shriveling of apples as indicated by moisture loss by weighing and by observation of the fruits through the storage period in the blower-equipped storage, provided that a relative humidity of 85 to 90 per cent was maintained.

It was also found that there was a slightly better keeping of the fruit in the center of the stacks than on the floor or on the top layer of the stacks due to the higher relative humidity prevailing within the stacks of fruit.

Contrary to common belief the air velocity throughout most of the storage equipped with forced-air or blower fans was not great, that is, it was of the order of 10 to 20 linear feet per minute 7 to 12 feet from the grille face and was usually much less (from 0 to 10 feet per minute) in most other parts of the storage.

By subjecting several crates of apples to high air velocities (from 400 to 900 feet per minute) with low (65 per cent) and high (90 per cent) relative humidities it was possible to show that the transpiration of apples is increased only slightly by moving air providing the relative humidity is maintained at a high level.

It was not possible in this series of tests to detect any value in coating the inside of apple crates to prevent moisture being lost from the fruits to the crates nor any value in covering the concrete floor to prevent any absorption of moisture by the floor from the crates and in turn from the fruits. There was an advantage in wetting the crates before placing them in storage to reduce the absorption by the crates of moisture from the air. As much as 600 gallons of water may be absorbed from the air of the storage by 10,000 bushel slatted crates during the early storage period.

In conclusion it may be said that all evidence points to the fact that, providing the relative humidity of the storage air is maintained at from 85 to 90 per cent, the air movement encountered in blower equipped storages will not cause greater moisture loss and shriveling of apples than in similar storages with gravity air movement only.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

Ohio farm land values have advanced by nearly 50 per cent since 1940 or 80 per cent since 1933. Land prices are now at the same level as in 1916.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	......	101	102	104	100	105	101
1914	99	......	100	101	102	102	105	109
1915	102	......	105	99	103	107	106	112
1916	125	......	124	118	113	113	121	123
1917	172	......	149	175	140	119	182	201
1918	192	......	176	204	175	131	203	243
1919	202	......	202	215	204	135	218	270
1920	225	......	201	211	236	159	212	230
1921	142	......	152	124	164	134	132	134
1922	141	......	149	132	145	124	127	133
1923	147	......	152	143	160	122	134	147
1924	143	......	152	143	165	118	133	150
1925	151	......	156	156	165	110	159	180
1926	146	......	155	146	170	105	155	183
1927	139	......	153	142	173	99	147	171
1928	141	......	155	151	169	96	154	163
1929	139	......	154	149	169	94	151	172
1930	126	......	146	128	154	90	128	142
1931	107	84	126	90	120	82	89	105
1932	95	58	108	68	92	70	63	77
1933	96	61	108	72	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	109	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	122	118	75	128	164
1938	115	87	123	97	117	74	103	145
1939	113	103	121	95	117	76	95	146
1940	114	117	122	100	116	77	99	148
1941	127	170	131	124	138	80	127	199
1942	144	227	154	159	173	89	160	266
1943	150	......	164	192	216	97	193	319
1943								
January	149	268	158	182	196	......	174	283
February	149	275	160	178	......	......	177	261
March	150	282	161	182	......	97	181	287
April	151	284	162	185	212	......	190	296
May	152	289	163	187	......	......	199	318
June	151	293	164	190	221	......	199	317
July	150	291	165	188	229	......	195	322
August	150	298	165	193	......	......	200	307
September	150	301	165	192	......	......	197	307
October	150	311	166	192	228	......	199	374
November	150	312	167	192	......	......	198	405
December	150	308	169	196	......	......	199	352
1944								
January	150	306	169	196	229	......	190	318
February	151	305	170	195	......	......	190	301
March	151	303	170	196	......	111	192	318
April	152	......	170	196	......	......	192	309
May	152	......	170	194	243	......	192	324
June	151	......	170	193	......	......	193	335

*SOURCE: Bureau of Business Research, The Ohio State University.

BULLETINS AVAILABLE

It is now possible to obtain the following bulletins which have not previously been announced in the Bimonthly Bulletin.

Size of Farm Units as Affected by the Farming of Additional Land, by R. C. Headington and J. I. Falconer, Bulletin 637

Public Revenue in Ohio with Especial Reference to Rural Taxation, by J. D. Thewlis and J. I. Falconer, Bulletin 638

Levels of Living and Population Movements in Rural Areas of Ohio, 1930-1940, by A. R. Mangus and Robert L. McNamara, Bulletin 639

Aggregation of an Orchard and a Vegetable Soil Under Different Cultural Treatments, by Leon Havis, Bulletin 640

Artificial Insemination of Dairy Cattle, by C. E. Knoop and W. D. Pounden, Bulletin 641

Ohio Agricultural Statistics 1940 and 1941, by Glenn S. Ray, Oakley M. Frost, and P. P. Wallrabenstein, Bulletin 642

Combine Harvester Investigations, by G. W. McCuen and E. A. Silver, Bulletin 643

Relationship Between Fat Content of Dairy Grain Mixtures and Milk and Butterfat Production, by C. F. Monroe and W. E. Krauss, Bulletin 644

A Comparative Study of Cotton and Rayon Glass Curtain Fabrics, by Florence E. Petzel, Bulletin 645

Food Consumption of College Men, by Hughina McKay and Mary Brown Patton, Bulletin 646.

Ohio Forest Plantings, by Robert R. Paton, Edmund Secrest, and Harold A. Ezri, Bulletin 647

The Ring-legged Earwig, *Euborellia annulipes* **(Lucas),** by C. R. Neiswander, Bulletin 648

Factors Relating to the Selection of Sewing Thread, by Florence E. Petzel, Buletin 649

Farmers' Elevators of Ohio Fifteen Years, 1928 to 1943, by B. A. Wallace and J. I. Falconer, Bulletin 650

Insect Pests of Strawberries in Ohio, by Ralph B. Neiswander, Bulletin 651

Factors Affecting Milk Supply in Canton, Akron, Dayton, and Portsmouth, by C. G. McBride, Bulletin 652

These and all bulletins of the Ohio Agricultural Experiment Station are free to residents of Ohio who request them from the Mailing Room, Ohio Agricultural Experiment Station, Wooster, Ohio.

BIMONTHLY BULLETIN

VOL. XXIX NOVEMBER-DECEMBER, 1944 NO. 231

OHIO AGRICULTURAL EXPER

WOOSTER, OHIO

OHIO'S HARDWOODS

(Cover Page)

One has only to drive past an army supply depot to be impressed with the important contribution which wood is making in the war program. Long rows of tools and machinery, many having wooden handles, held in wooden crates, and stored under wooden sheds offer ample evidence.

When the war started, the feeling prevailed that the huge stock piles of lumber then on hand would meet all demands, especially if civilian uses were substantially reduced.

The pinch finally came and was first felt in the central hardwood region where there was an early call for large quantities of white oak for boat timbers. Later yellow poplar was needed for airplane veneer and, for some time, large logs of this species could be used for no other purpose. The increased production of handles of all kinds placed a premium on white ash, which is a choice wood for such uses.

Even before the war, Ohio was using its saw timber more rapidly than it was being produced, and, if labor were available, the drain on the remaining stands would be several times the growth.

To furnish this much needed raw material many woods have been cut over which were cut during the first World War. The large white oak was, for the most part, virgin timber frequently 200 or more years old.

Assuming that a lasting peace is realized, Ohio farmers will have less timber in the woodlots from which to obtain construction lumber, posts, and fuel. Log sales to bolster the family income will be less frequent. Since available natural resources will continue to be a measure of a nations wealth and power, serious thought should go to the management of woodlands—not only existing woodlands, but also the thousands of acres of abandoned or idle land which could be devoted to a future timber crop.

The Division of Forestry is in position to assist in the management of existing stands of hardwoods, and, through its nurseries, young trees can be supplied at low cost for reforestation purposes.

CONTENTS

CHRISTMAS TREE TEST

ROBERT R. PATON

Christmas trees are necessarily cut some time before they are placed in the homes, this period varying from a day to several weeks. When the cut tree is placed in a heated room transpiration increases, with the result that in a short time the tree becomes thoroughly desiccated and the foliage begins to drop. This shattering of the foliage varies with different species; hemlock needles fall very quickly, while Douglas fir, balsam, and others hold their needles much longer.

Norway spruce, a species commonly used in Ohio for Christmas trees, holds its needles from several days to 2 weeks under average house conditions. However, many people prefer to leave their trees in the house for 2 weeks or longer and this species will not usually remain attractive that long without special treatment.

With a view toward increasing the duration of attractiveness of the Norway spruce, the butts of the trees are now often placed in water by householders.

An experiment to test the effectiveness of keeping the butt of the tree in water while in a heated room was carried out. Four Norway spruce trees were placed in water in a heated room (68° to 70° F.) on the day of cutting and four each on the first day, the fifth day, and the tenth day after cutting, respectively. The cut trees were stored outdoors until such time as they were needed inside. As a check on the effectiveness of the water treatment, each time four trees were taken inside and placed in water, four others were taken into the same room but were not placed in water.

The butts of other trees were shellacked at the time of cutting; these trees were taken inside and, after removing the butts, they were placed in water. Again, four trees were taken in on the day of cutting, and four each on the first, fifth, and tenth days after cutting, respectively, as in the above test. As checks on this procedure four shellacked trees were brought into the room on each of the first and tenth days after cutting, the butts were left on, and the trees were not put in water.

RESULTS

The trees which were cut and not put in water began to shatter in less than 14 days[1] in nearly all cases (only 4 out of 16 retained their needles more than 14 days). The average length of time that the trees were in the room before shattering took place, irrespective of the number of days since cutting, was 12.6 days for all the check trees (varying from 8 to 19 days); whereas, the average length of time that the trees which were put in water retained their needles was 21.9 days (varying from 7 to 56 days). This difference is highly significant.

[1]The number of days indicates the length of time the trees were in the room and does not include any days that the trees were stored outdoors.

One tree took up over a pint of water during the first 24 hours it was inside, and it remained in good condition for 56 days. After the first day this tree gradually took up a little water throughout the entire period, and on the fifty-sixth day the needles were still firm although they were turning brown. The other trees varied in the amount of water absorbed from a few tablespoonfuls to a cupful of water each day; some of this water, of course, evaporated from the surface of the water.

In contrast with this long-lasting tree, there was one which shattered on the seventh day and another on the tenth day, although both these trees were in water. All other trees placed in water held their needles for 12 days or longer, and 7 of the 20 held their needles for 30 days or longer. None of the trees that were not placed in water held their needles for more than 19 days.

The trees which were put in water soon after cutting (i. e., the first or second day) lasted an average of 19.25 days, while the checks lasted only 12.9 days. This difference was not significant in this case (Standard error, 6.0). Trees which were held outdoors for 5 or 10 days and then were placed in water lasted 23.67 days, while the checks averaged 12.3 days. This difference was highly significant (Standard error, 3.17).

The shellacking of the butts had no advantage in any case. The differences were slight and in no case significant. Where the trees were shellacked and later placed in water (after removing 4 inches of the butt), they lasted an average of 20.25 days; in contrast, those trees which were not shellacked but were placed in water lasted 21.9 days. Shellacked trees which were not placed in water lasted 12.1 days, while untreated trees lasted 12.6 days.

It was evident, during the test, that those trees which had the darkest green color survived longer than the yellow-green colored trees. This difference was not measured in any way, however.

Later, a single tree was placed in water in a heated room after a branch had been sawed from the tree and then replaced on it by boring a hole into the trunk and inserting the branch firmly. The cut branch began shattering in 7 days, while the balance of the tree remained green for 18 days; in fact, it did not shatter badly for 3 days longer.

CONCLUSIONS

Norway spruce which had been cut for up to 10 days and stored outdoors retained their needles for an average of 12 days after being placed in a heated room. Trees which were set in water at the time they were placed in the room retained their needles nearly 10 days longer, on an average.

Shellacking the butts at the time of cutting had no advantage.

There was a considerable variation between individuals in their reaction to being placed in water; however, nearly all of the trees showed some benefit from the water treatment and several of them retained their needles for a month or longer.

This experiment was carried out in a room kept fairly constantly at about 68-70 degrees Fahrenheit. No moisture was added to the atmosphere by the heating system, but the trees themselves undoubtedly contributed some to the humidity. The humidity was not measured. Private homes are frequently kept at higher temperatures than that in the room used in this test and undoubtedly are often drier. Trees under such conditions would shatter earlier than those in the above test, and thus they might well benefit more by having the butts placed in water.

It is apparent from this test that purchasers of Norway spruce cut trees may find the needles shattering in a few days. Ordinarily, however, one may expect the trees to last for at least a week, and, if they are placed in water and the water level maintained, the trees may retain their needles for 3 weeks, or even longer.

"OKLAHOMA GRIMM" PROVEN A FRAUD BY TESTS AT COLUMBUS

C. J. WILLARD

Until recently no single variety of alfalfa has been more widely recommended or more widely known than Grimm. Grimm, however, is a northern variety, and in recent years there has been a distinct shortage of true Grimm seed as well as of other northern-grown alfalfas. On the other hand, production of alfalfa seed in the southwestern states actually increased during the same period.

Consequently, there was a large and unsatisfied demand for Grimm and other variegated alfalfas. Thus, during the past 10 years the custom grew up among some seedsmen of calling much Oklahoma alfalfa "Oklahoma Grimm".

The simple fact is that there is only a trace of true Grimm alfalfa grown in Oklahoma. It is not adapted there for hay production and is seldom planted. H. F. Murphy, head of the Department of Agronomy at Oklahoma Agricultural and Mechanical College, wrote in January, 1943:[1] "It can be definitely stated that very little Grimm alfalfa is grown in this State."

Despite this well-known fact, until 1944 an increasingly large proportion of alfalfa seed from Oklahoma was sold in Ohio under the fraudulent label "Oklahoma Grimm". To combat this fraud the Department of Agronomy at Columbus, in cooperation with the Ohio Division of Plant Industry of the State Department of Agriculture, sowed 27 samples of alfalfa picked up by official inspectors of the state seed laboratory under the label "Oklahoma Grimm" in the spring of 1943. These samples were of lots being distributed by the leading wholesalers of alfalfa seed in the state of Ohio. For comparison, seven samples labeled Oklahoma common and two samples of variegated alfalfas, one known to be Grimm and the other known to be Meeker Baltic, were sown in the same nursery. All samples were sown at Columbus in small broadcast plots, 4 x 8 feet.

[1]In a letter to C. J. Willard under date of January 23, 1943.

The only way by which Grimm or other variegated alfalfas can be distinguished from common alfalfas with any satisfaction is by the amount and character of the bloom. In central Ohio Grimm blooms more freely than common alfalfa, and the bloom shows a higher percentage of variegation. Records were taken on this nursery on June 14 of this year when the two variegated strains, Grimm and Meeker Baltic, were in full bloom and showed a considerable amount of variegation. None of the lots from Oklahoma, whether labeled "Grimm" or common, showed much bloom, and what bloom there was showed very little variegation. It was clearly evident that none of the 27 samples which were labeled "Oklahoma Grimm" was Grimm, as was predicted from the fact that Grimm alfalfa is not found in Oklahoma.

Under the OPA ceiling regulations for 1944 and 1945 no premium price may be charged for Grimm alfalfa unless it is certified by a recognized certifying agency of the state in which the seed is produced. Since the Oklahoma Crop Improvement Association does not certify Grimm alfalfa, this should be an aid in disposing of the "Oklahoma Grimm" fraud.

There has also been some Kansas common alfalfa sold as "Kansas Grimm", although not to the same extent as "Oklahoma Grimm". There is very little more Grimm alfalfa in Kansas than in Oklahoma, and, with a very few exceptions, "Kansas Grimm" was also a fraud.

The important thing is for Ohio farmers to realize that practically none of the seed sold as "Oklahoma Grimm" ever was Grimm. If they have had satisfactory results with it, they should now ask for Oklahoma alfalfa. If they have not, it is not the fault of the Grimm variety but of those who utilized the good name of "Grimm" to obtain a higher price for inferior seed.

WHAT ALFALFA FOR OHIO IN 1945?

C. J. WILLARD AND L. E. THATCHER

For many years, the Ohio Agricultural Experiment Station has recommended the variegated varieties of alfalfa, which include Grimm, Hardigan, Ontario Variegated, Cossack, and Baltic, over common alfalfas for northern and central Ohio. It has also definitely recognized that locally produced alfalfa seed or seed from the same latitude and grown under the same climatic conditions is superior to that produced in a different latitude and under different conditions. Consequently, first choice would be alfalfa seed produced in Ohio, Indiana, Michigan, and Ontario; second choice, alfalfa seed produced in states west of Ohio from Minnesota and the Dakotas south to Oklahoma. Alfalfa seed from the southwest, New Mexico, Arizona, and southern California, and all commercially available imported seed except Canadian, has been notably less productive. A brief summary of relative yields of varieties and sources is presented in Table 1.

TABLE 1.—Relative yields of alfalfa varieties

Northwestern Grimm=100

Variety	Yield per acre Grimm=100 (1)	Yield per acre Grimm=100 (2)	Variety	Yield per acre Grimm=100 (1)	Yield per acre Grimm=100 (2)
	Pct.	*Pct.*		*Pct.*	*Pct.*
Variegated alfalfas (3)			**Common alfalfas (3)**		
Grimm (Northwestern)	100	100	Ohio	107*	....
Ohio variegated	106	....	Montana	97	99
Ladak	106	103	Dakota	96	99
Ontario Variegated	105	102	Nebraska	97	98
Hardigan	102	106	Oklahoma	99	96
Cossack	102	101	Kansas	94	95
Baltic	97	104	Idaho	93	94
			Utah	93	93
Foreign alfalfa			New Mexico	93	88
Argentine	92	84	California (Southern)	83	73
			Arizona	78	68

*This average is from one experiment only, but other experiences indicate that Ohio-produced seed of common alfalfa is at least equal to Northwestern Grimm. As common alfalfa does not produce seed in Ohio as well as variegated, most Ohio seed is likely to be of variegated origin.

(1) Average of seven tests at Wooster, six at North Ridgeville, and five at Columbus, of which one was harvested for one year only, five for 2 years, five for 3 years, five for 4 years, and one for 5 years. The averages above were weighted according to the number of years each test continued.

(2) Average of four tests at Holgate, two harvested for 3 years and two harvested for 4 years. The tests at Holgate and North Ridgeville were conducted by the Division of Forage Crops and Diseases, U. S. Department of Agriculture, in cooperation with the Ohio Agricultural Experiment Station.

(3) Common alfalfas are of the ordinary purple-flowered species, botanically *Medicago sativa*; variegated alfalfas have resulted from natural crosses between the common alfalfa and yellow-flowered alfalfa, *M. falcata*. The name "variegated" comes from the fact that some of the flowers are brown, green, greenish-yellow, or smoky, instead of the common blue or purple. All alfalfas are cross-pollinated and highly variable, so that when grown in one locality for several seed generations, they become better adapted to that region than the original seed. It is this fact of regional adaptation that gives signicance to the different sources of common alfalfa.

Note that Ohio-produced seed of the variegated alfalfas have been equal to or superior to any other source; Hardigan, which originated in Michigan, has been outstanding, with Cossack, Baltic, and Ontario Variegated almost as

good; common alfalfa from the Dakotas and Montana is slightly but definitely superior to that from Kansas and Oklahoma, with Nebraska intermediate; common alfalfas from Utah and Idaho are slightly inferior to any of these.

All of the above information applies to the northern two-thirds of Ohio. In the southern third of the State there is little or no advantage for variegated over common alfalfa.

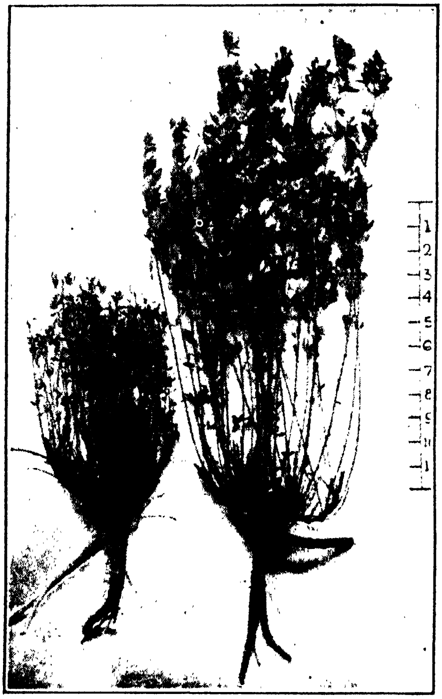

Fig. 1.—Bacterial wilt of alfalfa

Columbus, September 9, 1933—Left, typical alfalfa plant affected by bacterial wilt, from stand sown in 1926; right, normal plant dug less than one foot from the diseased plant. Wilt-infected plants were fairly common in the field but were always single plants like the above, not in patches.

These experiments were conducted from 1923 to 1940. Is there any reason to change these recommendations for 1945?

The outstanding development of the past 15 years in alfalfa culture in Ohio has been the gradually increasing seriousness of bacterial wilt in the State. The symptoms of bacterial wilt are not conspicuous and, hence, are quite frequently overlooked. If the bark of the root is peeled from an alfalfa plant suffering from wilt, the surface of the central woody part of the root will be various shades of brown instead of the creamy white found in healthy alfalfa. The tops are stunted; the leaves are yellow or pale green, and often crinkled. Especially, in the fall, there are many short stems from each crown instead of a few vigorous shoots (fig. 1). Just after frost, leaves of plants infected with wilt are likely to be more or less frosted, while healthy plants are uninjured.

Severe wilt attacks are likely to develop during the summer; these wilt attacks do not affect the first cutting but they become conspicuous in the third cutting and in fall growth to one who is familiar with the symptoms of the disease. Those who are not familiar with the symptoms of wilt find the field badly killed out the next spring, and they call it "winterkilling."

Just how the bacteria causing this disease have been introduced into Ohio fields is not certain. It is clear that they are now almost universally distributed over the State and that no special efforts to keep them out of any given field are justified. Even 15 years ago a survey of alfalfa fields from Columbus 60 miles south showed affected plants in every field visited.

Bacterial wilt develops most rapidly and seriously on wet, poorly drained soil types and in such spots within a field. The bacteria enter the roots most

readily through injuries, the most common of which are those caused by winter freezing. The next most common type of injury is that caused by implements of various kinds. This means that an alfalfa field should not be cultivated, since the roots injured in cultivation are readily infected with wilt. Actual tests have shown that cultivated alfalfa fields kill out from wilt much sooner than uncultivated fields. In order to reduce the injury from winter freezing, the last cutting should not be made after September 7 in northern Ohio and September 15 in southern Ohio. This is good advice under any circumstances, but it becomes particularly important when wilt is prevalent.

It has been reported that wilt does not develop as rapidly in alfalfa-grass mixtures as in pure alfalfa, but our observations do not bear this out. Both at Wooster and Columbus, wilt has developed as rapidly and as seriously in alfalfa-grass mixtures as in adjacent pure alfalfa. However, as alfalfa plants die out in such alfalfa-grass mixtures, their places are taken by grass instead of weeds and thus the hay production is larger. Unquestionably, alfalfa-grass mixtures are advantageous under wilt infection.

Aside from not cultivating, making the last cutting early, and growing alfalfa in mixtures (all of which are good practices whether wilt is present or not), no practices now followed in Ohio in growing alfalfa need be changed to meet the wilt situation. Attempts to check infection are fruitless. Desirable rotations should not be changed. Even sowing alfalfa again immediately in a field where alfalfa has just been destroyed by wilt does not necessarily result in heavy wilt infection in the new crop.

Wilt develops slowly, so that one good year of production, and usually two, are obtained before wilt affects the stand and yield.

The only available control for bacterial wilt is through the use of resistant varieties. Unfortunately, the variegated alfalfas, which are best for much of Ohio in every other way, are more susceptible to wilt than any other group of varieties. This is evident from the results of long-time tests at Columbus, reported in table 2.

TABLE 2.—Alfalfa variety tests at Columbus under wilt infestation

	Yields per acre in the first year of cutting			Yields per acre after wilt infection		
	A 1930	B 1934	C 1939	A 1935*	B 1937*	C 1941
	Lb.	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
Variegated alfalfas	5600	8640	10910	2350	1570	6240
Adapted common alfalfas	5080	8250	9820	3180	1870	6650
Wilt-resistant alfalfas	3690	7700	10030	4670	3300	9230

*1st cutting only.

Note that in the first year, the variegated alfalfas considerably outyield the common alfalfas and these in turn outyield the wilt-resistant strains (an exception in "C"). After wilt infection, 2 to 5 years later, the order is exactly reversed and the variegated alfalfas make up the lowest yielding group.

The wilt-resistant varieties in these tests were those with natural resistance, Turkistan and Hardistan. These varieties are not well adapted to Ohio. For 15 years plant breeders have been breeding wilt-resistant alfalfas which are better adapted to our conditions. Two such varieties, Ranger from Nebraska and Buffalo from Kansas have recently been introduced; both the breeding and the introduction have been in cooperation with the Division of Forage Crops and Diseases of the U. S. D. A.

Field scale tests of these varieties in comparison with older standard varieties were sown at several points in Ohio in 1941. Severe wilt infection developed in the test at Columbus during the summer of 1943. Relative resistance to wilt, therefore, is shown forcibly by the yields in 1944 (figures 2 and 3). The test at Wooster showed wilt damage late in the summer of 1944, but the 1944 yields are not greatly affected. The test at Holgate has shown only a little wilt damage so far. The yields are given in table 3.

TABLE 3.—Alfalfa variety tests, Columbus, Wooster, and Holgate, sown 1941

Average 2 plots each variety at Columbus, 3 plots each variety at Wooster and Holgate. Arranged in order of yield in 1942 at Columbus. Two cuttings

Variety	Columbus* Yield per acre 1942	Columbus* Yield per acre 1944	Columbus* Rank 1944	Columbus* Stand Sept. 1944	Wooster* 1943	Wooster* 1944	Holgate* 1942
	Lb.	Lb.	Lb.	Pct.	Lb.	Lb.	Lb.
1 Baltic	6360	2250	17	14	8030	4520	5520
2 Kansas Common	6310	4280	11	34	7670	6080	4970
3 Ontario Variegated	6280	3260	14	18	....	....	5340
4 Turkistan 19300	6240	5080	6	55	....	....	5390
5 Mercer Co., Ohio, Variegated	6160	3110	15	24	8030	6530	5650
6 Buffalo (A-11)	6120	6030	1	72	7630	5920	4340
7 Ranger (A-136)	6120	5580	3	68	7570	5580	4940
8 Grimm (Northwestern)	6090	3480	13	16	7530	6080	5460
9 Hardigan	5990	2720	16	18	7900	6120	5660
10 A-147 (Kansas)	5960	5770	2	61	7570	6840	4360
11 A-8 (Kansas)	5850	5400	4	58	7630	6850	4130
12 Dakota Common	5800	4940	8	42	....	....	5430
13 Hyman Grimm (Ohio)	5780	4580	10	38	7500	6300	6310
14 Hardistan	5480	4940	8	52	7630	4970	4730
15 Oklahoma Common	5420	4020	12	39	....	....	5070
16 Turkistan 86696	5270	5220	5	58	....	....	6040
17 Turkistan 19302	4530	5080	6	60	....	....	4710
Average Variegated	6110	3280	....	21	7800	5900	5660
Average Common	5840	4410	....	38	7670	6080	5160
Average Wilt-resistant	5700	5390	....	60	7610	6030	4830

These tests were conducted in cooperation with the Division of Forage Crops and Diseases, U. S. D. A.

*Yields were not obtained in 1942 at Wooster and in 1943 at Columbus and Holgate. 1944 data from Holgate are not available.

The Columbus data show in the third year the reactions already seen in previous years (table 2), but Ranger and Buffalo are not as inferior to variegated alfalfas in the first year as the earlier Turkistan and Hardistan varieties. These results check with data and observations from other trials in Ohio and from many other states. Both Ranger and Buffalo are satisfactory wilt-resistant alfalfas.

At present, there is some commercial production of seed of Ranger. No seed of Buffalo is commercially available, nor will there be any for at least 2 years.

For 1945, then, if you expect to leave your alfalfa only one or 2 years, locally produced and other variegated alfalfas are the first choice, and adapted common alfalfa is second, as heretofore. If the alfalfa is to stand 3 years and you have had difficulty with wilt, there is little choice between common and variegated varieties, because the somewhat greater wilt-resistance of the common alfalfas nearly balances the initial advantage of the variegated varieties.

If wilt hs given difficulty on your farm and you want alfalfa to stand more than 3 years (or, when seed is more readily available, more than 2 years), it is worth while to try to obtain seed of Ranger. Do not use this alfalfa for short rotations or where wilt has not appeared. It averages about 5 per cent lower yield than variegated strains the first year; furthermore, using Ranger seed in this way takes seed away from those who really need it.

Fig. 2.—Columbus, July 11, 1944. Sown in 1941.
Left, Buffalo. Right, Baltic

When seed of Buffalo becomes available, present indications are that it will be superior to Ranger for at least the southern two-thirds of Ohio. Ranger is the more winter-hardy, so there is still some question as to the superiority of Buffalo in northwestern Ohio.

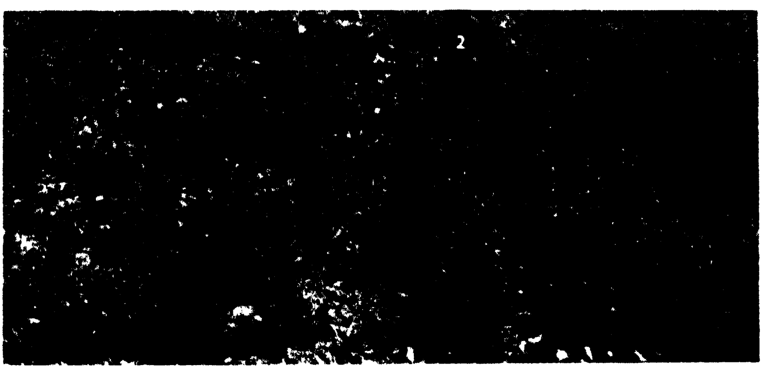

Fig. 3.—Columbus, June 28, 1944. Sown in 1940.
Left, Hardigan. Right, Ranger

STRAWBERRY VARIETY PERFORMANCE IN OHIO

WESLEY P. JUDKINS

The descriptive material and evaluations of strawberry varieties presented in this article are compiled largely from observations made in variety test plantings located at Wooster, Ohio. The reports of growers located in other areas have influenced the final ratings.

The varieties are divided into three groups depending upon their desirability for: (1) extensive commercial planting, (2) limited commercial planting, or (3) to satisfy special local demands or conditions. Within each group the varieties are arranged in order of ripening season. Everbearing varieties are listed at the ends of the three above enumerated groups and are indicated by "Ev." in the column headed "Ripening period."

The numerical values in the table indicate the desirability of a variety as far as ripening date, yield, fruit size, firmness, and quality are concerned. The figure "1" represents maximum or top value; "2" denotes very good; "3" means good or average; "4" indicates fair; and "5" denotes poor. In the case of the ripening period "1" means early; "2" represents early-midseason; "3" denotes midseason; "4" indicates late-midseason; and "5" means late.

The ratings are compiled chiefly from the point of view of the commercial grower. Selections for the home garden would be similar, but personal preference may have more influence in the final choice.

One of the most important factors which influences the profits from strawberries is yield. Although plants of different varieties vary in their ability to produce heavy crops of berries, in most cases the principal factor influencing yield was the number of plants per row or per acre during the fruiting season. This fact emphasizes the importance of selecting a good variety and the following of cultural practices which insure the development of large numbers of vigorous plants. In varieties such as Blakemore, which tend to form excessively compact rows, higher yields may be obtained by a system of spacing which improves the size and vigor of the individual plants.

TABLE 1.—Evaluation of strawberry varieties for Ohio

(Additional experience in different parts of the state may change the rating of the varieties here listed.)

Variety	Ripening period	Yield	Fruit size	Fruit firmness	Fruit quality	Remarks
Most important commercial varieties						
Shelton	1	1	2-3	3	3	Color rather light.
Premier	**2**	1	**2**	**2**	**2**	**Standard commercial variety.**
Catskill	3	1	2	3	2-3	A new standard commercial variety.
Green Mountain	Ev.	2	2-3	2-3	3	Very promising everbearer.
Varieties for limited commercial planting						
Dorsett	2	3	2	2-3	2	High quality; average yields.
Dresden	2	2-3	2	3	3	Better in north than south.
Fairfax	3	2-3	2	2	1	High quality but dark color.
Pathfinder	3	1-2	3	3	3	Resistant to Red Stele.
Sparkle	3	2	3	2	3	Resistant to Red Stele.
Redstar	5	3	2	2	2-3	Good late variety; average yields.
Gemzata	Ev.	3	2-3	3	3	Higher yield than many everbearers.
Varieties to satisfy special local demands						
Blakemore	1	3	3	2	4	Form excessive runners.
Daybreak	1	3-4	3	2	3	Better in south than north.
Fairmore	1	3	2-3	2	2-3	Better in south than north.
Majestic	2	2	3	4	3-4	Soft fruit; fair quality.
Maytime	2	3	3	2-3	2-3	Better in south than north.
Dunlap	2	3	3	4	2	Fruit soft; adapted to heavy soils
Northstar	3	3-4	2	2-3	3	Good fruit but yield low.
Clermont	3	3	2	2	2	Catskill preferred.
Culver	3	3	2	3	3	Catskill preferred.
Aberdeen	3	2	2-3	4	4	Resistant to Red Stele.
Burgundy	4	3	2	3	3	Fruit dark colored.
Redwing	4	3-4	3	2	3	Yield too low.
Ambrosia	4	4	2	3	3	Yield too low.
Aroma	4	3	2-3	1	4	Adapted to heavy soils.
Starbright	4	4	2	2	3	Yield too low.
Chesapeake	4	4	2-3	2	2-3	Yield low; needs rich soil.
Gandy	4	4	3	2	3	Adapted to heavy soils.
Julymorn	5	3-4	2	2-3	3	Needs moist soil.
Xtralate	5	4	2	3	3	Yield too low.
Mastodon	Ev.	4	3	3	3	Susceptible to leafspot.
Gem	Ev.	5	3	3	4	Yield too low.
Wayzata	Ev.	4	3	3	2-3	Yield too low.

CORN-AND-COB MEAL FOR GROWTH OF PULLETS AND EGG PRODUCTION

D. C. KENNARD AND V. D. CHAMBERLIN

The current interest in corn-and-cob meal for feeding livestock has created an interest among poultrymen as to its possibilities for feeding poultry.

During the past year, this Station has conducted three preliminary tests to determine the effect of rather coarsely ground corn-and-cob meal, instead of a corresponding amount of coarsely ground corn, on the growth of pullets and one experiment with layers.

FOR GROWTH OF CHICKENS

No advantage, and possibly a disadvantage, attended the use of corn-and-cob meal in the rations for growing pullets during the first 10 weeks, starting with day-old chicks, table 1. In contrast to the negative results of two of the experiments, the third experiment showed some beneficial effect when the feeding of corn-and-cob meal was started with 8-week old Leghorn pullets and then continued until the end of the twentieth week. This suggests the advisability of not feeding corn-and-cob meal until after the chickens are 8 to 10 weeks of age. Comparable results later secured from layers which were fed corn-and-cob meal instead of ground corn further substantiated this conclusion.

TABLE 1.—Effect of corn-and-cob meal in the rations on growth of chickens

Ration with:	Experiment No.	Breed	Age		Duration of experiments	Weight of birds		Gain in weight	Feed consumption	
			Start	Finish		Start	Finish		Per bird	Per pound gain
			Days	*Days*	*Weeks*	*Lb.*	*Lb.*	*Lb.*	*Lb.*	*Lb.*
39% ground corn*........	1	Rhode Island Red pullets	1	70	10	0.094	1.57	1.48	4.70	3.70
39% corn-and-cob meal*....						0.094	1.36	1.27	5.32	4.19
69% groued wheat*.......	2	Leghorn pullets	1	70	10	0.081	1.39	1.31	4.57	3.49
63% corn.and-cob meal*....						0.081	1.28	1.20	4.72	3.93
27% ground corn*........	3	Leghorn pullets	56	140	12	0.800	2.48	1.68	13.07	8.57
27% corn-and-cob meal*....						0.800	2.69	1.89	14.24	7.93

*Coarsely ground.

FOR EGG PRODUCTION

In the one experiment where corn-and-cob meal was substituted for ground corn in the ration for layers, practically the same egg production, body weight of layers, and feed consumption resulted as in the group which received the same ration with ground corn. Since the corn-and-cob meal contained about 20 per cent cob material, there was a saving of about 6.0 per cent of total feed intake (ingredients other than cob material) to be credited to the corn-and-cob meal.

TABLE 2.—Corn-and-cob meal in the ration for layers, 80 Rhode Island Red pullets in each group

(February 16 to August 31, 1944—28 weeks

Ration with:	Egg production		Weight of pullets		Feed consumption	
	Per bird	Per cent	At start	Average*	Per bird	Per dozen eggs
			Lb.	*Lb.*	*Lb.*	*Lb.*
31% corn-and-cob meal	98	50	4.92	5.73	58.47	7.12
31% ground corn	97	49	4.93	5.79	57.15	7.09

*Of monthly weights.

The results which have been presented are merely a preliminary report of the Station's limited work with the use of corn-and-cob meal for feeding poultry. Further work (which is in progress) will be necessary to determine whether or not corn-and-cob meal has advantages over ground corn in mash mixtures for poultry.

A DEVICE FOR TESTING THE BREAKING STRENGTH OF SHELL EGGS

D. C. KENNARD

A primary requirement of shell eggs to be marketed is that they have strong shells capable of withstanding the usual shocks while being handled and transported. The strength of the egg shells depends upon numerous factors, such as the hen's diet, the rate of egg production, the length of period of egg production, breeding, state of health, and weather conditions.

There has long been a need for a simple, practical device by which comparatively large numbers of eggs can be tested for shell strength. The best measure of shell strength is a shock test, whereby the eggs are subjected to similar breakage conditions encountered in handling and transporting operations. The device herein described for testing the shock strength of shell eggs was designed to meet these needs.

THE PRINCIPLES OF THE PROCEDURE

The shock test of egg-shell strength is based upon a given fixed arbitrary standard which will permit 90 to 100 per cent of the normally strong shelled eggs to pass the test without breaking. All eggs to be tested are then subjected to this fixed standard. The standard of measure (the intensity of shock) can be varied according to the shell strength of the eggs (usually the strongest) to be used as the standard. The standard may be adapted to a given experiment or to the breed, variety, or the strain of chickens from which eggs are to be tested.

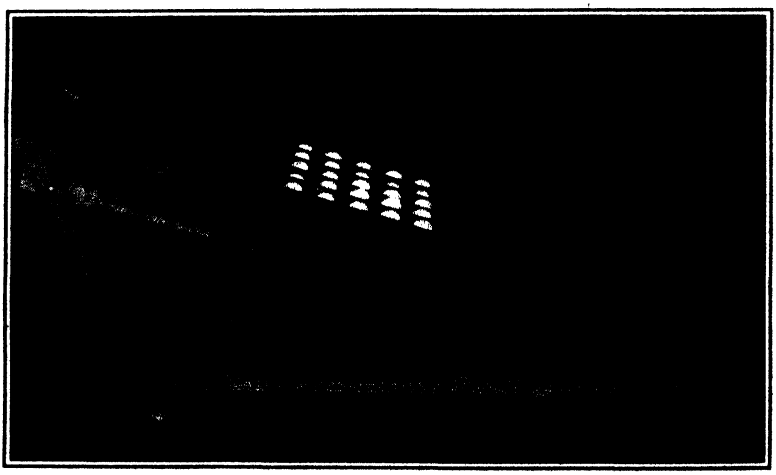

Fig. 1.—A device for testing the shock strength of shell eggs

The standard of the intensity of shock can be readily adapted to meet any requirement by either decreasing or increasing the angle of descent of the egg carriage or by varying the distance of its travel.

The design of the device is simple and the details of construction, except for the measurements, are evident from the photographs. In brief, the device consists of the supporting framework, the track, and the egg carriage.[1]

METHODS OF PROCEDURE

The egg-shell testing device (fig. 1) is placed on a table or bench about 30 inches high and is anchored firmly by wood screws ¼ by 1¾ inches in each end of the front and rear bottom cross pieces. The egg carriage, which accommodates 25 eggs, is placed on the lower end of the track where the carriage is filled with the eggs to be tested. The eggs to be tested can be weighed before testing without involving much extra time. Then, the eggs are placed in the egg filler with the small ends down at a slight angle towards the front of the egg carriage and to one side so that the upper large-end portion of each egg rests against the front and one side of the egg compartment. The eggs are slightly clinked together while placing them in the egg-carriage filler in order to eliminate any eggs that may have been cracked before testing. When the eggs are in place, the egg carriage is pushed to the top of the track and the lever of the holding device (fig. 2) is pushed down to engage the rear guide of the egg carriage (fig. 3). Then the egg carriage is brought down to where it is held in place by the holding device. When the egg carriage is brought from the top of the track to the holding device, the casters will automatically take the proper position (if all the casters make proper contact with the track) for the descent down the track when the egg carriage is released. To release the egg carriage, the holding lever is pushed upward until the egg carriage is released and descends to make the impact of a dead stop at the lower end of the track. Then the egg carriage is removed to a convenient working position, the egg filler carefully removed, and the eggs again clinked to detect any cracked shells. The detection of cracked shells by clinking is a simple, rapid, and dependable procedure well adapted for testing a large number of eggs. In fact, the eggs can be tested at the rate of 150 or more per hour. Over 20,000 eggs have been tested this year at the Ohio Agricultural Experiment Station in connection with the various experiments dealing with the effect of diet or management procedures on the strength of egg shells.

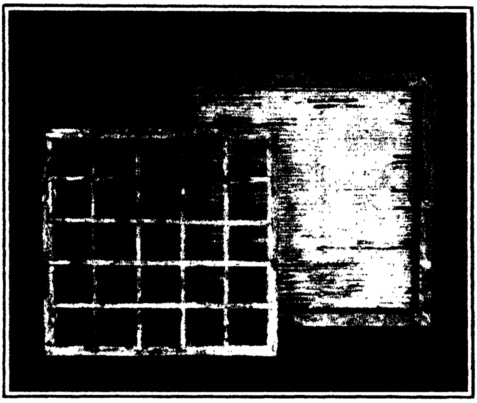

Fig. 2.—Top view of egg carriage

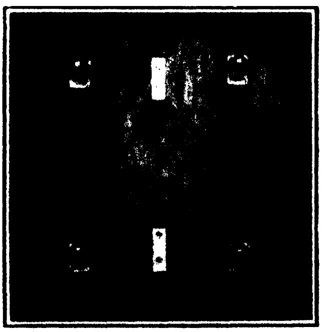

Fig. 3.—Bottom view of egg carriage

[1]For directions for construction write the Ohio Experiment Station, Wooster, Ohio.

TABLE 1.—Egg-shell strength as affected by the free-choice feeding of oyster shell, granite grit, and P. F. G. (poultry feeding grade, 90 per cent or more calcium carbonate) limestone grit

Rhode Island Red pullets; October 1, 1943, to August 3, 1944

Ration with:	Test	Dates of tests	Number of eggs tested	Per cent breakage	Weight per dozen eggs
		1943			*Ounces*
Oyster shell and granite grit	1	December 17	148	16	24.57
	2	January 14	50	2	25.67
	3	February 18	121	9	25.70
	4	March 8	85	16	26.06
	5	April 27	107	14	26.02
	6	May 23	108	39	25.60
	7	July 3	92	49	25.26
	8	August 3	93	42	25.06
Granite grit	1	December 17	64	64	24.82
	2	January 14	31	65	25.97
	3	February 18	70	83	25.47
	4	March 8	36	64	24.96
	5	April 27	65	86	25.98
	6	May 23	67	73	25.37
	7	July 3	65	57	26.01
	8	August 3	32	87	24.81
	9*	August 16	76	12	27.35
P. F. G. limestone grit	1	December 17	152	14	25.89
	2	January 14	87	16	25.97
	3	February 18	167	12	26.35
	4	March 8	119	23	26.30
	5	April 27	108	24	26.85
	6	May 23	106	24	26.55
	7	July 3	107	42	26.19
	8	August 3	108	41	27.38

*These eggs were collected August 4 to 16, during which time the hens had free access to oyster shell after August 2.

TABLE 2.—Egg-shell strength as affected by P. F. G. (poultry feeding grade, 90 per cent or more calcium carbonate) limestone grit versus dolomitic (magnesia) limestone grit

Rhode Island Red pullets; February 16 to September 9, 1944

	Test	Dates of tests	Number of eggs tested	Per cent breakage	Weight per dozen eggs
		1944			*Ounces*
Free choice of P. F. G. limestone grit	1	May 2	107	20	24.02
	2	June 2	103	15	24.97
	3	July 7	105	17	24.90
	4	August 22	200	28	24.75
	5	August 28	95	8*	24.84
	6	September 1	117	9	25.89
	7	September 5	130	11	25.42
	8	September 9	73	18	25.47
Free choice of dolomitic (magnesium) limestone grit	1	May 2	101	47	24.11
	2	June 2	97	53	23.74
	3	July 7	80	64	23.40
	4	August 22	137	46	24.19
	5	August 28	128	40	25.61
	6	September 1	73	37	25.60
	7	September 5	65	17†	25.09
	8	September 9	42	9	25.77

*Cool weather after August 22.
†P. F. G. limestone grit after September 1.

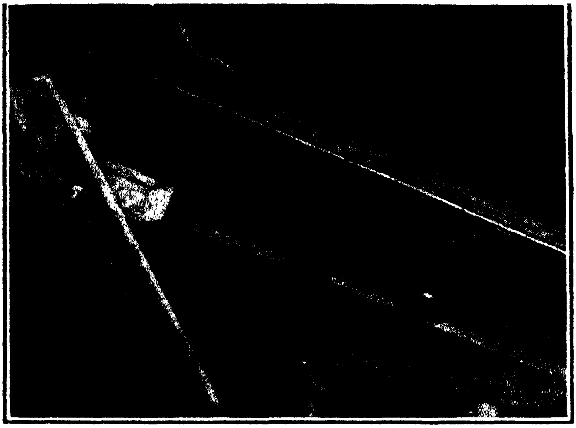

Fig. 4.—Mechanical device for release of the egg carriage

SOME RESULTS SECURED FROM THE USE OF THE EGG SHELL TESTING DEVICE

The primary object of presenting the following data is to familiarize poultry research workers and poultrymen with the egg-shell testing device being used at the Experiment Station, rather than to interpret the data which will be dealt with more in detail later.

That a suitable calcium supplement for egg shell formation is as important as any part of the hen's diet is clearly indicated in table 1. The effect of the warm weather during July and August is obvious in the lessened shell strength from the hens which received the calcium supplements. The hens which received granite grit without the calcium supplement were obliged to lay weak shelled eggs, regardless of the weather. When, at the end of the experiment, oyster shells were added to the diet of the layers there was a prompt response in the production of hard-shelled eggs. At the same time, there was a substantial increase in the number and size of their eggs.

The liabilities attending the promiscuous use of limestone grits, which may contain too much magnesia instead of oyster shell or other suitable shell products sufficiently high in calcium, are indicated by the results of the experiment with P. F. G. (poultry feeding grade, 90 per cent or more calcium carbonate) limestone grit versus dolomitic (magnesia) limestone grit (table 2).

While the shell strength of the eggs laid by the fall-hatched pullets (having access to P. F. G. limestone grit) which started to lay in March was much less affected by the hot weather than that of the spring-hatched pullets, there was a prompt improvement in shell strength of the eggs after the onset of cool weather during the last week of August.

SUMMARY

A device in use at the Ohio Agricultural Experiment Station for testing the comparative shell strength of eggs has been described.

Some of the data from the two experiments have been presented to acquaint research workers and poultrymen with the egg-shell testing device and the type of results which can be secured by the use of the device.

1943 APPLE COSTS IN OHIO

CHAS. W. HAUCK

This study of apple costs in Ohio was made at the request and with the assistance of the Ohio Apple Institute. It was designed to ascertain from individual records and estimates of a selected group of commercial growers the costs of growing, harvesting, packing, and storing apples in this State in 1943. Lacking records from typical orchards that have been kept uniformly for a period of several years by approved cost accounting methods and subjected to audit, data for the study were assembled by means of questionnaires returned by 136 orchardists in 49 counties, representing, in the main, the larger and better-cared-for commercial orchards in the State. For the purposes of this study, these growers were asked to fit their records into an agreed uniform schedule.

The 1943 costs were strongly influenced by wartime factors, such as high wage rates, relative inefficiency of labor, high cost of materials and supplies, and also by the unusually short crop of apples in Ohio in that year. The data are not presented as typical of a normal year, since 1943 yields were approximately one-half those of the 2 preceding years. It is believed, however, that the data are representative of costs in the commercial orchards of the State in 1943. Information was not available to permit comparisons with costs in earlier years.

The basic data compiled from these 136 returns are set forth below:

Number of growers reporting	136
Number of acres of bearing apple trees	6,114
Number of bushels of apples produced, 1943	588,042
Number of bushels of apples produced, average of 1941-1942	1,108,211
Average number of bushels produced per acre, 1943	96
Average number of bushels produced per acre, 1941-1942	181
1943 yield as per cent of average, 1941-1942	53.1
Investment in land	$ 268,985.31
Investment in orchard (bearing trees only)	1,159,200.03
Total investment in land and bearing trees	1,428,185.34
Investment in buildings	775,591.47
Investment in machinery and equipment	613,776.14
Total investment	$2,817,552.95

Overhead costs reported or computed from the foregoing facts, together with direct growing and harvesting costs reported, appear in table 1.

It will be noted that overhead cost represented more than one-third and direct growing cost about one-half of the total for 1943. Harvesting cost, being more nearly proportional to yield, no doubt was a smaller part of the total than is the case in seasons of normal production. Labor, exclusive of management, made up more than 36 per cent of the total, the largest single item by far. Obviously, labor expense was increased by wartime wage rates and relative inefficiency of unskilled, inexperienced, or physically inferior workers. Combined management and labor cost amounted to almost 50 per cent of the total. Materials and supplies (exclusive of field crates, other items listed as equipment, shipping containers, and other packing supplies) accounted for 16 per cent of the total.

TABLE 1.—Distribution of overhead costs, direct growing costs, and harvesting costs of 136 Ohio apple growers, 1943

Item	Costs: Dollars	Costs: Per cent of group total	Costs: Per cent of grand total
Interest @ 4% of $2,817,552.95	$112,702.12	29.83	11.55
Depreciation:			
Buildings—3% of $775,591.47	23,267.73	6.16	2.38
Machinery and equipment—10% of $613,776.14	61,377.61	16.25	6.29
Orchard (trees only)—10% of $1,159,200.03	46,368.00	12.27	4.75
Taxes paid	19,665.61	5.21	2.01
Management	114,376.23	30.28	11.72
Total overhead cost	$377,757.30	100.00	38.70
Production labor	230,152.17	50.07	23.58
Fertilizer and lime	28,516.59	6.22	2.92
Spray and dust materials	87,182.08	18.96	8.93
Gas, oil, feed, electricity	37,578.65	8.17	3.85
Repair of buildings and equipment	37,229.37	8.10	3.81
Mulching material	5,439.57	1.18	0.56
Insurance	18,604.11	4.05	1.91
Other direct growing cost	14,952.78	3.25	1.53
Total direct growing cost	$459,685.32	100.00	47.09
Harvesting labor	124,991.33	90.13	12.81
Other harvesting cost	13,689.44	9.87	1.40
Total harvesting cost	$138,680.77	100.00	14.21
Total cost to and including harvesting	$976,123.39	....	100.00

These costs are itemized in table 2 in terms of average cost per acre and per bushel, distributed over 6114 acres and 588,042 bushels produced in these orchards in 1943.

TABLE 2.—Distribution of overhead costs, direct growing costs, and harvesting costs of 136 Ohio apple growers, 1943, per acre and per bushel

Item	Cost per acre	Cost per bushel
	Dollars	*Dollars*
Interest	$18.42	$0.192
Depreciation: Buildings	3.81	.040
Machinery and equipment	10.04	.104
Orchard (trees only)	7.58	.079
Taxes paid	3.22	.033
Management	18.71	.194
Total overhead cost	$61.78	$ .642
Production labor	37.64	.392
Fertilizer and lime	4.67	.048
Spray and dust material	14.26	.148
Gas, oil, feed, electricity	6.15	.064
Repair of buildings and equipment	6.09	.063
Mulching material	0.89	.009
Insurance	3.04	.032
Other direct growing cost	2.44	.026
Total direct growing cost	$75.18	$ .782
Harvesting labor	20.44	.213
Other harvesting cost	2.24	.023
Total harvesting cost	$22.68	$ .236
Total cost to and including harvesting	$159.64	$1.66

Slightly more than one-half of the growers reported packing and storage costs per bushel. Since those reporting basket costs represented all commercial sections in the State, and only minor variations existed in the costs reported, it was possible to construct a table of average unit costs which it is believed closely approximates the expense entailed in properly packing a bushel of U. S. No. 1 fruit in a new, round-stave bushel basket and carrying it in proper condition to the end of the cold storage season. A few returns were received itemizing costs when the apples were packed in one-bushel paper-board cartons or in wooden boxes, but the number of these returns was so small and the costs so variable that they have not been taken into account here.

TABLE 3.—Average unit packing and storage costs per bushel of U. S. No. 1 apples, reported by 78 Ohio growers, 1943

Item	Average cost per bushel	
	Dollars	*Per cent of total*
Grading and packing labor	$0.101	12.69
Basket, cover, pad, and liner	.237	29.77
Oiled paper	.035	4.40
Other packing cost	.044	5.53
Total packing cost	$ .417	52.39
Hauling to storage	.089	11.18
Commercial cold storage, seasonal rate	.290	36.43
Total packing and storage cost	$ .796	100.00

Package and packaging materials made up approximately one-third of this total, and almost one-half was accounted for by the storage charge and delivery to storage. Added to the $1.66 average cost to and including harvesting (table 2), the average packing and storage cost brings the appregate cost per bushel to $2.456, ready for sale from storage. This obviously does not include marketing expense.

It must be kept in mind that costs reported herein reflect unusual conditions.

INDEX NUMBERS OF PRODUCTION, PRICES, AND INCOME

J. I. FALCONER

For the first 8 months of 1944 the agricultural income of Ohio exceeded that of 1943 by 9 per cent.

Trend of Ohio prices and wages

1910-1914=100

	Wholesale prices, all commodities U. S.	Ohio industrial pay rolls 1935-1939 =100*	Prices paid by farmers	Farm products prices U. S.	Ohio farm wages	Ohio farm real estate	Ohio farm products prices	Ohio cash income from sales
1913	102	......	101	102	104	100	105	101
1914	99	......	100	101	102	102	105	109
1915	102	......	105	99	103	107	106	112
1916	125	......	124	118	113	113	121	123
1917	172	......	149	175	140	119	182	201
1918	192	......	176	204	175	131	203	243
1919	202	......	202	215	204	135	218	270
1920	225	......	201	211	236	159	212	230
1921	142	......	152	124	164	134	132	134
1922	141	......	149	132	145	124	127	133
1923	147	......	152	143	160	122	134	147
1924	143	......	152	143	165	118	133	150
1925	151	......	156	156	165	110	159	180
1926	146	......	155	146	170	105	155	183
1927	139	......	153	142	173	99	147	171
1928	141	......	155	151	169	96	154	163
1929	139	......	154	149	169	94	151	172
1930	126	......	146	128	154	90	128	142
1931	107	84	126	90	120	82	89	105
1932	95	58	108	68	92	70	63	77
1933	96	61	108	72	74	59	69	87
1934	110	77	122	90	77	63	85	102
1935	117	87	125	109	87	66	110	132
1936	118	102	124	114	100	71	118	152
1937	126	120	131	122	118	75	128	164
1938	115	87	123	97	117	74	103	145
1939	113	103	121	95	117	76	95	146
1940	114	117	122	100	116	77	99	148
1941	127	170	131	124	138	80	127	199
1942	144	227	154	159	173	89	160	266
1943	150	......	164	192	216	97	193	319
1943								
January	149	268	158	182	196	......	174	283
February	149	275	160	178	......	......	177	261
March	150	282	161	182	......	97	181	287
April	151	284	162	185	212	......	190	296
May	152	289	163	187	......	......	199	318
June	151	293	164	190	221	......	199	317
July	150	291	165	188	229	......	195	322
August	150	298	165	193	......	......	200	307
September	150	301	165	192	......	......	197	307
October	150	311	166	192	228	......	199	374
November	150	312	167	192	......	......	198	405
December	150	308	169	196	......	......	199	352
1944								
January	150	306	169	196	229	......	190	318
February	151	305	170	195	......	......	190	301
March	151	303	170	196	......	111	192	318
April	152	296	170	196	243	......	192	309
May	152	296	170	194	......	......	192	324
June	151	300	170	193	......	......	193	335
July	152	293	170	192	245	......	195	360
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*SOURCE: Bureau of Business Research, The Ohio State University.

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